# Influence of breed and housing system on eating quality of strongly marbled beef from steers

Hanne Grete Bang, Ejvind Ovesen and Marjatta Oksama, Danish Meat Research Institute, Roskilde, Denmark

**Background**

A special type of beef with - according to Danish tradition - an extreme level of marbling is produced in Japan. The meat is typically very tender and the fat is white and firm. It might be possible to market a product with these characteristics to Japanese restaurants in Europe. This is the background for a project, aimed at investigating whether it is possible to produce such a beef product in Denmark. The product should be based on Danish breeds and feeding systems, and the cost of production should be reasonable. The experiment was carried out over three years with steers of different breed combinations and testing different feeding intensities and housing systems. In the third and last year, the production method was tested on steers with Danish Jersey (DJ) as dam breed and DJ or Aberdeen Angus (AA) as sire breed.

**Objective**

The object of this part of the project was to investigate the eating quality of beef from steers (approx. 24 months of age) sired by DJ or AA. The steers were fed intensively to achieve a high level of marbling. The influence of the housing system on eating quality was also examined. The eating quality was established by sensoric assessment of sirloin samples and laboratory measurement of texture in loin and eye of round.

**Methods**

33 DJ and 40 AA×DJ bull calves were used in the test. At approx 4 months of age they were castrated. When they reached an age of 154 days, they were distributed to four housing systems. 16 steers of each breed combination were loose housed during the complete test period (L/L). 5-8 steers of each breed were either loose housed until reaching an age of 7 months and then tied (L/T), tied up to an age of 7 months and then loose housed (T/L) or tied during the complete period (T/T) . The animals were fed at a relatively low energy level until reaching an age of 15 months and then at a relatively high energy level until slaughter at approx. 24 months. Five of the steers left the test for various reasons.

The animals were transported to the abattoir under conditions respecting their housing at the experimental station - tied animals were transported tied and loose housed animals were transported loose. The animals were slaughtered immediately on arrival to the abattoir. The carcasses were electrically stimulated (low voltage for 30 seconds) after stunning and bleeding. They were chilled for 3-4 hours at 12°C, for 2-3 hours at 5°C followed by overnight chilling at 3°C and until carcass cutting. The *semitendinosus* muscle (ST) and a sample from the *longissimus dorsi* muscle (LD) at the 12th and 13th rib and the 1st lumbar vertebra were selected for laboratory analysis. Sirloin samples were taken for sensoric assessment. All samples were vacuum packed. The samples for laboratory analysis were aged for 8 days at 4°C. They were then distributed as follows: The caudal portion of LD and the middle of ST were cut out, vacuum packed and stored at -20°C for later measurement of texture. A 2 cm steak of LD was cut for colour measurement. The Hunterlab-colour (lightness, hue and saturation) of the steak was measured on a Datacolor Dataflash 2000 after blooming in atmospheric air for 80 minutes. The remainder of ST and LD was minced and used for determination of intramuscular fat using the Soxtec HT-$H^+$ method and total pigment content using the Hornsey method. The samples for texture measurement were thawed at 5°C, cooked to a core temperature of 72°C and chilled in cold water for 20 minutes. Six strips of 10×20 mm cross section were cut in a plane perpendicular to the direction of the fibre bundle. The maximum force required to chew 80% into each strip was measured with a Volodkevich shear attachment on a Karl Frank 81559.

The samples for sensoric assessment were aged for 16 days at 4°C and frozen at -20°C. Before sensoric assessment they were thawed at 4°C for 18 hours, cut into 23 mm steaks and cooked to a core temperature of 61-62°C (producing a medium cooked steak). The panel consisted of 8 trained assessors and evaluated colour of meat when fried, meat flavour, tenderness and juiciness. All traits were assessed on a scale from 0 to 8 according to an increasing intensity of each trait. The panel mean was calculated for each trait.

Data were analysed with PROC GLM in SAS version 6.04 (SAS, 1985) using the following statistical model:

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + (\alpha_i * \beta_j) + \gamma x_k + \epsilon_{ijkl}$$

where $Y_{ijkl}$ is the analysed trait, $\mu$ is the overall least square mean, $\alpha_i$ is the effect of the i'th sire breed, $\beta_j$ is the effect of the j'th housing system, $(\alpha_i * \beta_j)$ is the interaction between breed and housing system, $\gamma$ is the linear regression coefficient of age at slaughter ($x_k$) and $\epsilon_{ijkl}$ is the random residual.

**Results and discussion**

Table 1 shows the effect of breed and housing system on selected meat quality and eating quality traits. The intramuscular fat content (IMF) was high both in LD (10-11%) and ST (4-5%). There was no breed effect on IMF neither in LD nor ST. The shear force value was significantly higher in AA×DJ than in DJ meaning purebred DJ produced slightly more tender meat. However, the difference was slight and the shear force figures for both breeds were so low, that one could term the tenderness fine. The sensoric assessment of sirloin steaks confirmed the good eating quality for both breed combinations. The score for tenderness was 6.2 and 6.9, respectively on a scale from 0 to 8. DJ was assessed to be darker, more tender and juicy and to have a more pronounced flavour than AA×DJ.

The T/T and L/T steers had a significant higher IMF in LD and ST than L/L and T/L steers. The texture measurements in LD showed a tendency towards more tender meat in animals tied up prior to slaughter T/T and L/T. These results agree with earlier experiments, that tied animals deposit more fat into the muscles and produce more tender meat than loose housed animals (Andersen *et al.*, 1991; Jensen & Oksama, 1996). However, the effect of housing system on shear force was slight. T/L and L/L steers had a darker colour of meat when fried than tied animals (T/T and L/T). Similar results are found from the objective colour measurements (lightness, hue).

A darker meat colour for loose housed animals has been found earlier (Krippl & Burgstaller, 1970; Jensen & Oksama, 1996). There was no housing effect on any other traits in the sensoric assessment.

## Conclusions

Both shear force measurements and the sensoric assessment showed that the extremely marbled steer beef had an excellent eating quality. Purebred Jersey beef was more marbled and had a slightly better eating quality than beef from the Angus crosses. Animals which were tied prior to slaughter had a higher intramuscular fat content and a tendency towards better tenderness measured in the laboratory than animals which were loose housed before slaughter, but this difference was not confirmed in the sensoric assessment. However, the tenderness assessed by the panel showed a tendency in the same direction as the shear force measurements. Loose housed animals had a darker meat colour than tied animals.

In general terms, the investigation showed that it is possible to produce a special product with a high eating quality under Danish conditions. The financial outlook for such a special production depends on the possibility of obtaining a quality premium. The sale to Japanese restaurants is limited to specific cuts only. It is therefore important to investigate alternative uses of other cuts.

Table 1. Meat quality and eating quality. Least square means by sire breed and housing system.

| | LD | | | | | ST | | Sirloin - sensory panel scores | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | IMF (%) | Shear force, kg | Colour L[2] | Colour H[3] | Pigment (ppm) | IMF (%) | Shear force, kg | Colour | Tender-ness | Juici-ness | Flavour |
| DJ (n=29) | 9.8 | 4.1 | 35.7 | 26.2 | 211 | 4.6 | 8.2 | 6.0 | 6.9 | 7.0 | 6.6 |
| AA × DJ (n=39) | 11.0 | 4.7 | 37.4 | 27.0 | 191 | 4.6 | 9.8 | 5.5 | 6.2 | 6.7 | 6.3 |
| Level of significance[1] | ns | ** | *** | *** | *** | ns | *** | *** | *** | * | ** |
| L/L (n=31) | 8.7 | 4.6 | 35.7 | 26.0 | 211 | 4.1 | 9.4 | 5.8 | 6.4 | 6.8 | 6.3 |
| T/L (n=12) | 8.5 | 4.8 | 35.6 | 26.1 | 212 | 4.0 | 9.3 | 6.2 | 6.2 | 6.7 | 6.4 |
| T/T (n=11) | 12.1 | 3.9 | 37.1 | 26.9 | 195 | 5.1 | 8.5 | 5.6 | 6.8 | 7.0 | 6.4 |
| L/T (n=14) | 12.2 | 4.3 | 37.9 | 27.4 | 186 | 5.2 | 8.8 | 5.5 | 6.7 | 7.0 | 6.5 |
| Level of significance[1] | *** | * | *** | *** | ** | *** | ns | ** | ns | ns | ns |

[1] ns = p≥0,05; * = p<0,05; ** = p<0,01; *** = p<0,001; [2] Colour, Dataflash Lightness; [3] Colour, Dataflash Hue

## Literature


Andersen, H.R., Krohn, C.C., Foldager, J., Munksgaard, L. & Klastrup, S. (1991). *Influence of housing and feeding on behaviour, feed intake, growth and carcass and meat quality*. Report 700, Nat. Inst. of Anim. Sci., Tjele, Denmark.

Jensen, L.R. & Oksama, M. (1996). *Influence of different housing systems on carcass and meat quality in young bulls*. 42nd ICoMST, Lillehammer, Norway, 436-437.

Krippl, K. & Burgstaller, G. (1970). *Comparative experiments concerning the influence of various management systems on the development and carcass quality in fattening calves*. Züchtungskunde, **42**, 24-30.

SAS (1985). SAS stat. SAS institute Inc. Cary NC.



Acknowledgement: This investigation was carried out in cooperation with the Danish Institute of Agricultural Sciences, Research Centre Foulum, Department for Animal Nutrition and Physiology. H. Refsgaard Andersen managed the part of the investigation dealing with production housing, feeding etc.