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THE SIGNIFICANCE OF CONFORMATION IN RELATION TO BEEF CARCASS MERIT

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(Sleutelwoorde: *Bouvorm, karkaswaarde, beesvleis)*

Objective of meat production

In any meat production enterprise it is the maximum yield of saleable deboned product, with optimal organoleptic and processing qualities, containing only the required amount of fat, to acquire the highest unit price and which has been produced with the minimum amount of feed in the shortest possible time, that is the most important parameter by which the success of the system can be evaluated (Naudé, 1974).

Carcass value

The value of a carcass is therefore primarily determined by its yield of saleable meat. This concept implies that such meat should be trimmed of any fat which is in excess of the requirements of the consumer and most important of all that high quality carcasses should contain the maximum amount of muscle or lean. In short therefore, it is the different proportions in which the 3 most important tissues, muscle, fat and bone are found in carcasses that determine their relative economic values. A second economically important characteristic of a carcass, is its yield of high priced saleable meat relative to the cheaper less desirable cuts. The higher the proportion of muscle in the carcass which is found in the round, rump, loin and rib cuts, the higher will be the unit value of the saleable meat of that carcass. In the same manner the distribution of fat in the carcass contributes to the acceptability of its meat cuts. Internal fat of th chest cavity as well as kidney knob and channel fat are trimmed from the carcass and has to be sold by the butcher in South Africa at an appreciably lower unit price than the rest of the carcass. Excess subcutaneous, as well as intermuscular fat in the various cuts of the carcass, especially in the higher priced ones, will cause a decline in average income per kilogram of meat sold by the butcher. The merit of a beef carcass as discussed above has been very thoroughly described and reviewed in trade and scientific journals of the world by many a meat scientist (Callow, 1944; Butler, 1957; Luitingh, 1962; Tayler, 1964; Bray, 1964; Boccard, 1966; Everitt, 1966; Weniger, 1966; Barton, 1967; Brännang & Nilsson, 1969; De Boer, Bergström & De Rooy, 1969; Carroll, 1967, 1971; Preston & Willis, 1970; Butterfield, 1973a & b; Bergström, 1974; Harrington & Kempster, 1977; Allen Kilkenny, 1980).

A further characteristic of the carcass regarded by certain sectors of the meat industry as being economically important, is the thickness especially of roasting joints. The thickness of cuts is determined by the length of the bones of the skeleton to which the muscles are attached. Carcasses with relatively short bones have thicker muscles than those with longer bones when they have equal amounts of muscle. The fat content of a carcass, that is the fat found in between the muscles and on the subcutaneous surface, also has an influence on the thickness of joints, hence the different concepts of muscling and fleshing of a carcass (Charles, Butterfield & Francis, 1965; Martin, Walters & Whiteman, 1966; De Boer *et al.*, 1969; Carroll, 1971; Harrington, 1969, 1971; Bergström, 1974). In their manual regarding the carcass characteristics to be visually assessed in the classification system developed by the European Association of Animal Production, De Boer, Dumont, Pomeroy & Weniger (1974) defined the relevant concepts very clearly; Muscle - muscle fibres and intramuscular fat; Flesh - muscle and intermuscular fat; Muscularity - thickness of flesh relative to dimensions of skeleton; Fatness (fat covering) - development of fat cover relative to dimensions of carcass; Conformation - thickness of flesh and subcuteneous fat relative to dimensions of skeleton.

Traditionally, in the beef cattle and carcass markets the conformation or shape of the animal and its carcass has been regarded as indicative of a high meat to bone ratio as well as of the proportion of high priced cuts - described with terms such as "weak in the loin" and "well filled rump" (Harrington, 1969) or "more lean in the right places" (Allen & Kilkenny, 1980).

The object of this paper is to review the present knowledge and views of the subject and to highlight local research of relevance.

The market requirements for carcasses and meat vary widely between and within countries. Efficient marketing will depend upon the extent to which the type of product supplied will comply with these requirements. Eating and processing quality of the product is determined and well controlled during the biological production phase by the breed, sex, nutritional status, slaughter mass and age of animal provided the animal, its carcass and the meat are optimally handled prior to, during

When the results of cutting tests are used to compare carcasses in terms of the relative yield of high priced cuts, certain particulars of the slaughtered animals are of vital importance regarding conclusions arrived at. Because of differential growth rates which have been established between and within the 3 main body tissues, muscle, fat and bone, certain physiological characteristics of the animal which have a bearing on stage of maturity should be taken into account. These are the breed, age, sex, mass and fatness of the animal. Certain breeds are significantly earlier maturing regarding the onset of the third growth phase during which fat grows more quickly than muscle and muscle than bone. The age and mass of the animal within a breed could be associated with the anticipated fatness of the animal which may indicate stage of tissue maturity which again will be related to the relative growth and distribution of muscles in the different anatomical parts of the body. Therefore, when animals representing widely varying physiological types are slaughtered at equal fatness during the active growth phase the distribution of saleable meat is remarkably similar such as indicated by the work of the Meat and Livestock Commission in England in Table 2 (Kempster, 1979). At the same carcass mass these animals would have been at different stages of maturity. Therefore, the levels of fat content and patterns of muscle distribution would have been distinctly different and would result in different yields of high priced cuts. This has indeed been recorded in several studies (Naudé, Mentz, Venter, Nel, Botha, Stiemie & Argo, 1980; Preston & Willis, 1970; Berg & Butterfield, 1976). Even though these differences may be detected by anatomical dissection or commercial cutting, in animals of different physiological maturity, it is highly unlikely that differences would be detectable when the carcasses are visually appraised (Harrington, 1971).

In a classical sutdy with identical twins in which one of each pair was castrated, Brännäng (1966; 1971) demonstrated that the growth intensity of certain muscles in th neck and upper shoulder regions was markedly decreased in castrates (55% for the *M. splenius*). Hence, the well known phenomenon of the secondary sexual development observed in those muscles of intact males. Even though this is a characteristic of late maturing muscle growth in all sexes, it is much more pronounced in the intact male (Mukhoty & Berg, 1973).

Due to the early attainment of maturity in bone growth and the fact that muscle growth continues for a considerable period after the retardation of bone growth, the muscle to bone ratio increases until the phase during which fat grows more quickly than muscle. At this stage the muscle to bone ratio remains more or less constant (Tayler, 1964; Bergström, 1974). During the phase of increasing muscle to bone ratio an increase in the thickness of the fleshing of the body is also visually observed. During the fattening phase however thickening of the fleshing also occurs due to subcutaneous and intermuscular fat depostion. Because of the different maturing rates observed in breeds, and sexes reared under varying levels of nutrition, it is difficult to decide for the live animal when thickening of the flesh is due to an increase in the muscle to bone ratio or due to an increase in fat deposition in between and over the muscles.

A further difficulty encountered when attempting to relate the shape of an animal to the composition of its tissues is the fact that certain breeds or types of animals have smaller frame sizes or skeletal dimensions than others. Therefore, when compared at similar muscle masses, the taller animals will appear thinly muscled and the shorter animals more thickly muscled, even though

Table 2

Means of carcass characteristics for dairybred cattle at Sutton Bonington (years 1 to 3)

Sire breed* (n)		Carcass weight (kg)	Carcass saleable meat (%)	Saleable meat in higher priced joints (%)	Carcass** conformation
Aberdeen Angus	(24)	180	71,4	44,5	7,7
Charolais	(32)	262	71,6	44,9	8,8
Devon	(57)	186	70,7	44,6	6,9
Friesian	(47)	216	70,2	44,5	6,4
Hereford	(47)	196	70,8	44,4	7,4
Simmentaler	(33)	244	71,4	45,1	8,9
South Devon	(24)	228	71,4	44,2	7,7
Sussex	(29)	202	71,9	44,2	7,7

* Slaughtered at approximately 16 months old at estimated content of subcutaneous fat of 6,7%

** Conformation was scored on a 15-point scale

they might have exactly the same muscle and bone masses (Bergström, 1974). Two animals might even have the same bone dimensions and muscle masses but different bone thicknesses or masses. Consequently, they may have the same visual appearance but when dissected the muscle to bone ratios could differ significantly. From the above discussion it is clear therefore that the shape or conformation of a carcass is a very unreliable measure either of the distribution of saleable meat or of the muscle or lean meat to bone ratio. When the breed is known it could be of some guidance in estimating muscle to bone ratios of carcasses. This is because of the well known between breed variation (Anon. 1975a; Harrington, 1976) as well as the small within breed variation observed in inherent muscle to bone ratios (Vial, 1966) of carcasses. However, Brungardt (1970) found virtually no within breed differences in muscle to bone ratios when studying Charolais, Aberdeen Angus and Hereford progeny groups. In a situation where breed is unknown however, (the case at almost every carcass auction) conformation could be a very unreliable indicator of muscle to bone ratio due to the masking effect of the mass and length measurements of bones as well as deposition of subcutaneous and intermuscular fat (Anon. 1975b). It has been shown, however, in several studies that extreme shape differences, which do occur amongst breeds, could reflect significant differences in lean yield (Harrington, 1973; Bergström, 1974; Anon., 1975a). This applies only to a much lesser extent with carcasses having the normal kind of shape differences observed in slaughter stock finished for the beef market.

At the Animal and Dairy Science Research Institute at Irene carcass evaluation of 8 crossbred as well as 4 purebred types of steers was performed at each of the following live masses: 200, 340, 380 and 440 kg (Naudé *et al.*, 1980). The crossbreds were the progeny of Afrikaner dams and from sires of the following breeds: Hereford Simmentaler, Gelbvieh, Normande, Limousine, Blonde 'd Aquitaine, Charolaise and Chianina. The purebreds were of the Afrikaner, Bonsmara, Hereford and Simmentaler breeds. When all the data were pooled in a multiple regression analysis of fat percentage, age and carcass mass on meat yield percentage of the expensive cuts, the R value was found to be 0,78. Fat explained 34,5% of the variation, age 6,2% and mass 0,1%. With a range in fat percentage of between 2% and 38% and expensive meat percentage of between 37% and 48% the correlation between fat percentage and percentage expensive meat was −0,76 (Fig. 1).

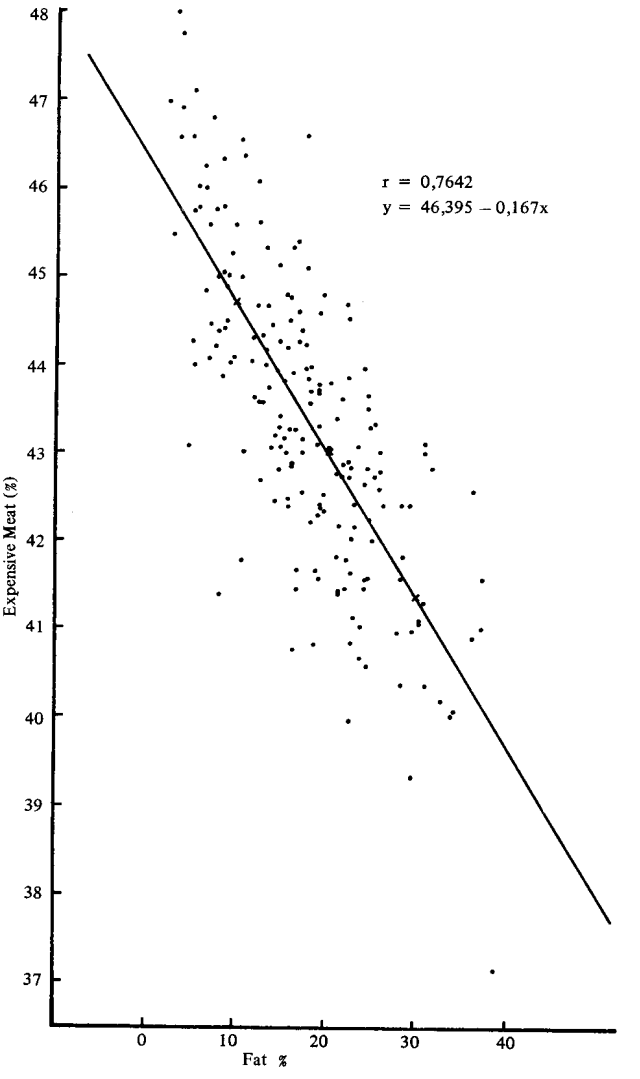

Fig. 1 Relationship between carcass fat content and percentage expensive meat in carcasses of steers of twelve breed types

Carcass classification and grading

The object of a classification system is to describe certain visual characteristics of a carcass such as conformation and fatness, or to measure these objectively. In addition it should supply information regarding sex and carcass mass as well as an estimate of age or maturity as judged by dentition or cartilage ossification. Information of this nature could then serve as a common language (Harrington, 1969) in the meat market where these parameters of carcass and meat quality could then be interpreted. In a grading system, however, quality evaluation is built into the system and carcasses are ranked in order of estimated excellence. For this purpose certain characteristics are then grouped together in a specific order each having a complimentary effect in determining the combined quality described by a particular grade. Harrington (1973) outlined the advantages of assessing fatness and conformation separately in a classification system as opposed to joint assessment in a grading system. He found that joint assessment frequently resulted in groups within and between grades having a rather confused mixture of fatness and conformation. Of the 5 characteristics, age, sex, mass, conformation and

Table 4

Average lean meat percentage for large samples of steers of various breeds and crosses (n = 725)

	Conformation class	Fat class					
		Leanest 1	2	3L	3H	4	Fattest 5
Best	5	70,5*	65,1	62,4	59,5	55,3*	51,6*
	4	67,5*	64,7	61,5	59,0	56,3	54,7*
	3	68,1*	64,0	60,9*	58,4	56,1	52,8*
	2	67,2*	64,1	60,3	58,2	54,1*	53,5*
Worst	1	67,0*	63,4	59,7*	-	-	-

* Less than 10 carcasses

steers were compared, Holstein steers had the lowest conformation score, least fat cover and highest retail yield and carcasses of Hereford and Angus sired steers, the opposite characteristics. In the USDA grades for carcass beef (Anon. 1967a) conformation has now been eliminated as a parameter of cutability and only fat thickness, kidney, pelvic and heart fat, carcass mass and area of eye muscle are used in the prediction equation. The validity of this procedure was verified and proved sound by the work of Abraham *et. al.* (1980).

In Canada Fredeen, Locking & McAndrews (1974) reported "a small but statistically significant superiority of beef carcasses in percent yield of boneless trimmed lean cuts" when compared to dairy carcasses.

In the Argentine (Anon., 1976) the "new" versus the traditional type of slaughter stock is being widely publisized; "New" type steers have an average mass of 460 kg and "traditional" ones 510 kg. The respective figures for fat content are 28%and 47%, for fat trim 9% and 30% and for "export" cuts 37% and 25%. What is being advocated here is slaughtering existing types at a smaller and leaner stage resulting in saleable meat yields of 79% versus 62% for the "new" and "traditional" types respectively as well as higher yields of high priced meat.

Visual carcass appraisal

Extremely thorough developmental work has been done during the past decade by the Meat and Livestock Commission (Harrington & Kempster, 1977) in developing sound principles for the visual assessment of carcasses to be classified for conformation and fatness. These visually appraised characteristics should enable the assessor to estimate as correctly as possible the cutability of carcasses which he had classified differently. The lean meat yeilds (%) of "many hundreds" of classified carcasses which had been dissected by their organization are given in Table 4. A small advantage of "some 2% of lean meat between extremes of conformation class 5 and 1 at fat class 2 and 3L" was demonstrated "and this is smaller than the difference between the average lean content of adjacent fat classes 2 and 3L averaged over all conformations". These conclusions are even more significant when considering the fact that 9 out of the 30 possible combinations of fat and conformation include (indicated by the block in Table 4) 80,8% (Anon. 1975b) of all classified carcasses in the United Kingdom.

The figures for saleable meat percentages of carcasses dissected in Ireland (Ryan, 1978) are given in Table 5.

The trends observed in the MLC-data are also evident in Table 5 with a large vairation in saleable yield between carcasses of different fat classes and a small variation between those of different conformation classes within a fat class. Variation due to conformation class within those groups commonly found on the market, was very small. In a study in South Africa, Klingbiel and his co-workers (1979) dissected 76 steer carcasses varying in carcass mass between 75 kg and 325 kg and representing all the grades in the specific mass groups found at the largest carcass auction in the country. All carcasses were scored by experienced graders (carcasses have been graded in South Africa for more than 40 years) for conformation and fatness on a 15 point scale. Regression analysis of the data produced the correlation values detailed in Table 6.

Klingbiel *et al.* (1979) noted from multiple regression analyses of the data that the relative contributions of conformation, fatness and carcass mass in explaining variation in carcass tissue percentages, were as given in Table 7.

Table 5

Subcell means for saleable meat percentage (n =575)

Conformation Class		Fat class						
		Leanest 1	2	3	4	5	6	Fattest 7
Best	I	-	75,3	73,6	68,8	71,1*	67,5	62,6*
	R	-	74,5*	70,3	69,2	68,1	67,8	63,9
	E	-	71,1	70,0	68,0	67,2	65,8	61,9
	L	70,4*	71,3	70,0	68,9	68,5	66,5	65,2*
	A	73,5	70,4	69,6	68,7	67,7*	64,0*	62,2*
	N	71,6	70,5	69,3	-	68,2*	-	64,9*
Worst	D	71,0	71,2	-	-	-	-	-

* Less than 5 carcasses

The results in Table 6 and 7 are in agreement with those of other reports (Harrington, 1969) in which it was stated that fatness score or even a single fat measurement on a carcass was a much more reliable predictor of saleable meat than conformation score. The correlation of -0,17 between conformation score and meat yield is in agreement with the results of Andersen (1974) and Riordon & Mellon (1978). The conclusion of Klingbiel *et al.* (1979) was that fatness should be the most important parameter in a grading system in which meat yield, as the main carcass quality parameter, is to be predicted. They found that 79,8% of the variation in carcass meat yield was explained by fat score of the carcass. Prescott & Hinks (1969) quote a figure of 64%. In an attempt to find objective measurements to estimate fatness as well as conformation they measured fat thickness at 6 different positions on the carcass. Of these a measurement on the unribbed carcass taken at a position between the 10th and 11th ribs 5 cm from the medial surface of the split side was found to have the highest correlation (r = 0,74) with the percentage dissected subcutaneous fat. This correlation was lower than that of the visual score for fatness and subcutaneous fat (r = 0,82). Harrington (1973) reported that ". . . assessments made by trained classifiers and measurements of fat thickness correlated equally well with actual fat percentages . . ." Harries, Pomeroy & Williams (1974) noted that visual appraisal by expert judges was reliable for assessing fatness, but less so for conformation. Similarly, an objective measure of conformation (kg carcass/cm carcass length) did not improve the correlation with meat yield (r = -0,15) (cf. Table 6: r = -0,17).

Conclusion

Attempts to change the conformation of livestock with the object firstly of improving the muscle to bone ratio and therefore the saleable meat yield of the carcass and secondly of improving the yield of high priced meat in the carcass will most probably not be very successful and could even lead to impaired fitness of breeding stock. Conformational characteristics indicative of functional efficiency in breeding and production stock should however, never be neglected in a production system. It has also been said that an attractive shape in the show ring and even in the carcass auction has a certain monetary value.

In carcass classification systems where the object is to describe visual carcass attributes as reliably as possible, information regarding conformation, fatness, sex, age and carcass mass should be stated without attaching any indication of predicted excellence to be deduced from the given information. However, in a grading system carcass conformation is of limited value in describing carcass merit. Fatness is the most important parameter of saleable meat yield as well as fat yield or amount of

Table 6

Correlations (r) between visual carcass scores and dissected carcass yield

Carcass tissue	Fatness	Conformation
Percentage subcutaneous fat	0,82	0,44 (0,41)*
Percentage meat (less S.C. fat)	-0,70	-0,17 (-0,09)*
Percentage bone	-0,62	-0,64 (-0,65)*
Percentage kidney and channel fat	0,60	0,32

Table 7

Multiple regression analyses results of carcass dissections – Percentage variation explained by 3 parameters

	R-value	Conformation	Fatness	Carcass mass
Subcutaneous fat %	0,82	0,25	67,68	0,81
Meat less S.C. fat %	0,75	11,10	79,78	0,07
Bone %	0,74	14,28	12,70	3,78

fat trim. Within fatness groups, conformation scores could be of value in eliminating extremely poor conformation types from the higher grades. These have been shown to yield slightly less saleable meat and more bone than better conformation carcasses with similar levels of fatness. Fatness of carcass is also inversely related to the yield of high priced meat in a carcass. This is because of the association of such yield with the stage of physiological maturity of the animal. Increase in carcass fatness beyond the stage of market requirements, has a continuos depreciating effect on the quantitative, qualitative and economic value of a beef carcass. Information regarding the influence of conformation on meat yield of carcasses of old cows long past the stage of continuous growth, is rather limited and should receive more attention. Leanness and a high muscle to bone ratio are most important characteristics in carcasses being used in the manufacturing sector of the meat industry.

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