CARCASS CHARACTERISTICS OF YEARLING NORMAL AND DOUBLE MUSCLE CROSS BULLS

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ARTHUR, P. F., MAKARECHIAN, M., PRICE, M. A. AND BERG, R. T. 1989. Carcass characteristics of yearling normal and double muscle cross bulls. Can. J. Anim. Sci. **69**: 897–903.

Data on 99 young bulls, which were the progeny of matings of either double muscle bulls and normal cows (DMx) or normal bulls and normal cows (N) born over three calving seasons, were analyzed to compare the carcass characteristics and lean yield of yearling DMx and N bulls. DMx carcasses had larger ($P < 0.001$) ribeye areas and cutability but smaller ($P < 0.001$) grade fat and average fat thicknesses than N carcasses, when the data were adjusted to either constant slaughter age (395.7 d) or constant carcass weight (304.7 kg). Muscle:fat and muscle:bone ratios and percent muscle in the 10th-11th-12th rib joint were higher ($P < 0.001$), while percent fat and percent bone in the rib joint were lower ($P < 0.005$) in DMx compared to N carcasses, when the data were adjusted to either constant grade fat thickness (10.0 mm) or constant rib joint weight (4871.4 g). The magnitude of the observed superiority of DMx over normal carcasses in lean yield was not the same across carcass grades. For A1 or A2 carcasses, rib joints from DMx carcasses had 8.8 and 5.7%, respectively, more ($P < 0.05$) muscle than those from N carcasses.

Key words: Carcass characteristics, double muscle, crosses, cattle

[Caractéristiques des carcasses de taureaux d'un an issus de croisément entre des sujets normaux et des culards.]

Titre abrégé: Caractéristiques des carcasses de culards croisés.

Les données sur 99 jeunes taureaux, issus de croisements entre des taureaux culards et des vaches normales (DMx) ou entre des vaches et des taureaux normaux (N) et nés au cours de trois saisons de vêlage, ont été analysées afin de comparer les caractéristiques des carcasses et le rendement en viande des sujets DMx et N d'un an. Dans le cas des carcasses des sujets DMx, le muscle long dorsal et la valeur au dépeçage étaient supérieurs ($P < 0,001$) à ceux des carcasses N, mais l'épaisseur du gras de couverture et l'épaisseur moyenne du gras étaient plus faibles ($P < 0,001$), après correction des données en fonction d'un âge constant à l'abattage (395,7 jours) ou d'un poids de la carcasse constant (304,7 kg). De plus, les rapports muscle: graisse et muscle:os, ainsi que le pourcentage de muscle au niveau des 10e, 11e et 12e côtes, ont été plus élevés ($P < 0,001$) chez les carcasses DMx que chez les carcasses N; le pourcentage de gras et d'os à ce niveau à toutefois été plus faible ($P < 0,005$), après correction des données en fonction d'une épaisseur constante du gras de couverture (10,0 mm) ou d'un poids constant (4 871,4 g) de l'articulation prélevée (10e, 11e et 12e côtes). La supériorité des carcasses DMx par rapport aux carcasses normales quant au rendement en viande a toutefois varié d'une catégorie à une autre. Pour les catégories A2 et A2, le pourcentage de muscle des carcasses DMx, au niveau des 10e, 11e et 12e côtes, a été respectivement de 8,8 et de 5,7% ($P < 0,05$) supérieur à celui des carcasses N.

Mots cles: Caractéristiques de la carcasse, culard, croisements, bovins

Double muscling in cattle is believed to be under the control of a single autosomal gene with modifier genes affecting its phenotypic expression (Nott and Rollins 1979; Menissier 1982b; Hanset and Michaux 1985). The double muscle (DM) syndrome is characterized by a generalized hypertrophy of muscles, a reduction in adipose tissue and a reduction in weight of the skeleton (Vissac 1968; Shahin and Berg 1985a). DM cattle, therefore, tend to have a higher dressing percentage, less inter- and intramuscular fat and a higher muscle:bone ratio than normal (N) cattle. Shahin and Berg (1985b) have shown that muscles most affected by the syndrome are the "high priced" muscles. DM cattle are, however, reported to show some degree of subfertility, higher incidences of dystocia and calf mortality and increased stress susceptibility compared to normal cattle (Menissier 1982a; Arthur et al. 1988).

While cattle showing the DM syndrome are used in commercial beef production systems in Europe, their deliberate use in North America has been limited to a few research herds. However, interest in the use of DM bulls in breeding programs has increased recently in North America. The feasibility of such breeding programs has been reported by Rollins et al. (1980) and Arthur et al. (1989a, b). In Canada, a higher price is often paid steer carcasses relative to heifer carcasses even at constant fatness (grades), partly in recognition of the greater lean yield of the former carcasses (Jones et al. 1987). For breeding programs involving DM cattle to be economically feasible, the higher lean yield of DM cross (DMx) carcasses should be reflected in the price paid for such carcasses. The objectives of this study, therefore, were (1) to compare the carcass characteristics of yearling DMx and N bulls, and (2) to ascertain if there is a superiority in lean yield for DMx carcasses within either A1 or A2 Canadian carcass grade classes.

MATERIALS AND METHODS

Animals and Management

Cattle showing the DM syndrome have been maintained at the University of Alberta ranch at Kinsella since 1967. It is a synthetic (composite) breed group, with the average breed composition of the breeding herd at the beginning of this study being approximately 47% Angus, 14% each of Charolais, Galloway and Hereford, and 11% other breeds. The normal (N) cattle was a group of crossbred cattle with no evidence of the DM condition with at least 50% Hereford breeding and the remaining percentage made up of Angus, Charolais and Galloway. Reciprocal crossing between DM and N cattle were made over three breeding seasons starting in the summer of 1983. Fifty-nine DM × N (DMx) and forty N × N (N) yearling bulls born over three calving seasons were used in this study. Details on the feeding and management of these animals have been reported by Arthur et al. (1989a).

Slaughter and Carcass Evaluation

Bulls approaching slaughter condition were measured ultrasonically (Scanogram Model 722, Ithaco, Ithaca, New York), at weekly intervals, for backfat thickness between the 12th and 13th ribs at the right side. Bulls with an estimated backfat thickness corresponding to the midpoint between the Canada A1 and A2 carcass grades (6–8 mm) were shipped for slaughter a week later. Bulls were fasted for 24 h, then trucked 150 km to a commercial packing plant in Edmonton, where they were weighed and slaughtered within a few hours of arrival. Carcasses were chilled (1–3°C) overnight after which carcass length was measured according to the method described by Yeates (1952). Agriculture Canada graders provided a grade and an appraisal for each carcass. The appraisal used was the standard ML 107 (blue tag) appraisal devised for Record of Performance testing, which consisted of a number of measurements including warm carcass weight, grade, meat color, marbling score (range 1–10, higher numbers mean less visible marbling), area of longissimus muscle (ribeye area) and fat cover at three positions over the longissimus muscle at the quartering (12-13th ribs) position. A few carcasses which were graded B1 in 1985 (first year of study) as a result of dark meat but which had fat thicknesses greater than 4 mm were reclassified as B2 to reflect the grading system which came into effect in 1986.

A 10th-11th-12th rib joint was removed from the right side of each carcass, trimmed according to the method described by Hankins and Howe (1946), and separated into fat, muscle and bone. The weight of each component was expressed as a percentage of the weight of the rib joint.

Statistical Analysis

Two sets of analyses were performed. The first set involved the whole data set, while the second involved data from either A1 or A2 carcasses only. In the first set of analysis, the data were analyzed on an age constant basis, using age at slaughter as a covariate. The mean age at slaughter to which all data were adjusted was 395.7 d. The data were also analyzed on either a weight constant basis, using either warm carcass weight (for carcass measurements) or rib joint weight (for rib joint measurements) as covariate or on grade fat constant basis using grade fat as a covariate. The mean carcass and rib joint weights to which the data were adjusted were 304.7 kg and 4871.4 g, respectively. The mean grade fat thickness to which all the data were adjusted was 10.0 mm.

In the second set of analysis, data on A1 and A2 carcasses were analyzed separately. For each grade the data were anlayzed first with no covariate, then with grade fat thickness as a covariate. The mean grade fat thickness to which the data were adjusted were 7.5 mm and 12.9 mm for A1 and A2 carcasses, respectively.

The data were analyzed by least squares procedures (Harvey 1985) using a fixed model with group (DMx or N) and year as main effects plus the interaction between the two effects. Ratio and percentage data were analyzed without transformation since preliminary examination of residual plots indicated that transformation was not required.

RESULTS AND DISCUSSION

At a constant age at slaughter (395.7 d), differences between DMx and normal carcasses for slaughter weight, warm carcass weight, carcass length, dressing percentage and marbling score were not significant ($P > 0.05$; Table 1). DMx carcasses had larger ($P < 0.005$) ribeye areas and cutability, but had smaller ($P < 0.001$) grade fat and average fat thicknesses compared to normal carcasses. Similar results were obtained when the data were adjusted to a constant carcass weight (304.7 kg) (Table 1).

Muscle:fat and muscle:bone ratios, and percent muscle in the 10th-11th-12th rib joint were higher ($P<0.001$) in DMx compared to normal carcasses, when the data were adjusted to either a constant grade fat thickness (10.0 mm) or a constant rib joint weight (4871.4 g) (Table 2). Percent fat and percent bone in the rib joint were lower ($P < 0.005$) in DMx compared to normal carcasses. The similarity in the results obtained when the data were evaluated at either age constant, weight contant or grade fat constant (Tables 1 and 2) suggests that there are important genetic differences between the two groups for these carcass traits.

Table 1. Least squares means and standard errors for carcass characteristics of double muscle cross (DMx) and normal bulls

	Age constant basis†			Weight constant basis‡		
	DMx	Normal	P§	DMx	Normal	P§
No. of bulls	59	40		59	40	
Age at slaughter (d)				398.0 ± 2.2	395.1 ± 2.3	0.398
Slaughter wt. (kg)	498.2 ± 7.0	516.9 ± 7.8	0.078	504.1 ± 2.7	510.4 ± 3.0	0.124
Warm carcass wt. (kg)	300.6 ± 4.3	309.1 ± 4.7	0.187			
Carcass length (cm)	118.9 ± 0.7	120.7 ± 0.8	0.092	119.3 ± 0.5	120.2 ± 0.6	0.266
Dressing percentage	60.4 ± 0.3	59.8 ± 0.4	0.237	60.6 ± 0.3	59.7 ± 0.4	0.111
Ribeye area (cm^2)	92.1 ± 1.5	84.9 ± 1.7	0.002	93.1 ± 1.3	84.1 ± 1.5	0.001
Cutability (%)	60.2 ± 0.2	58.6 ± 0.3	0.001	60.3 ± 0.2	58.5 ± 0.3	0.001
Grade fat (mm)	9.1 ± 0.5	11.3 ± 0.5	0.001	8.9 ± 0.5	11.3 ± 0.5	0.001
Average fat (mm)	10.4 ± 0.4	12.7 ± 0.4	0.001	10.3 ± 0.4	12.6 ± 0.5	0.001
Marbling score¶	7.5 ± 0.1	7.4 ± 0.1	0.763	7.5 ± 0.1	7.4 ± 0.1	0.882

†Using age at slaughter as covariate (mean of 395.7 d).
‡Using warm carcass wt. as covariate (mean of 304.7 kg).
§Probability of significance.
¶1, most marbled; 9, least marbled.

Table 2. Least squares means and standard errors for dissected components of 10th-11th-12th rib joint of double muscle cross (DMx) and normal bull carcasses

	Grade fat constant basis†			Weight constant basis‡		
	DMx	Normal	P§	DMx	Normal	P§
No. of bull carcasses	59	40		59	40	
Rib joint wt. (g)	4785.1 ± 87.5	4884.0 ± 97.7	0.466			
Dissected fat wt. (g)	1395.7 ± 34.7	1520.8 ± 38.8	0.022	1372.7 ± 31.6	1577.4 ± 34.9	0.001
Dissected muscle wt. (g)	2709.7 ± 56.1	2608.8 ± 62.7	0.247	2802.8 ± 31.4	2548.0 ± 34.6	0.001
Dissected bone wt. (g)	676.0 ± 14.1	749.9 ± 15.7	0.001	692.6 ± 9.4	741.0 ± 10.3	0.001
Muscle:fat	2.1 ± 0.1	1.8 ± 0.1	0.001	2.2 ± 0.1	1.7 ± 0.1	0.001
Muscle:bone	4.0 ± 0.1	3.5 ± 0.1	0.001	4.1 ± 0.1	3.5 ± 0.1	0.001
Percent fat	28.8 ± 0.4	30.7 ± 0.5	0.006	27.8 ± 0.6	32.0 ± 0.7	0.001
Percent muscle	56.8 ± 0.5	53.7 ± 0.5	0.001	57.8 ± 0.6	52.5 ± 0.7	0.001
Percent bone	14.3 ± 0.2	15.5 ± 0.2	0.001	14.4 ± 0.2	15.4 ± 0.2	0.001

†Using grade fat thickness as covariate (mean of 10.0 mm).
‡Using rib joint wt. as covariate (mean of 4871.4 g).
§Probability of significance.

While the superiority of DM over N carcasses in lean yield has been well documented (Dumont 1982; Shahin and Berg 1985a), there have been few published reports on the lean yield of the progeny from crossing DM and normal cattle, especially under a North American management system. The results obtained in this study clearly indicate that lean yield, as reflected in the percent muscle in the rib joint, of DMx carcasses is higher than that of normal carcasses. This finding is similar to the results obtained by Rollins et al. (1980) in the United States.

The distribution of carcass grades for DMx and normal carcasses is presented in Table 3. All the carcasses were graded as youthful (Maturity I, potential Canada A grade). While there is concern that DM animals may not fatten adequately to make the Canada A carcass grade, all the DMx carcasses had sufficient fat, except for one (2%) carcass which had less than 4 mm of backfat (B1 grade). A higher percentage (24 vs. 15%) of dark meat was observed among DMx than among N carcasses ($P > 0.05$). However, further studies are recommended to specifically address the incidence of dark carcasses among DMx animals.

Under the Canadian grading system, carcasses of the same grade can vary in backfat thickness (grade fat) by up to 5 mm. Carcass data for each grade were, therefore, first analyzed with no covariate and then with

Table 3. Distribution of carcass grades from double muscle cross (DMx) and normal bull carcasses

Carcass grade	DMx No.	DMx Percentage	Normal No.	Normal Percentage
A1	28	47	12	30
A2	14	24	18	45
A3	2	3	4	10
B1†	1	2		
B2‡	14	24	6	15

†Insufficient fat (< 4 mm).
‡Dark cutting.

grade fat thickness as a covariate, to obtain uniformity of carcass fat thickness within grade. Within the A1 carcass grade, rib joints from DMx carcasses had higher ($P < 0.01$) muscle:fat and muscle:bone ratios and percent muscle and lower ($P < 0.002$) percent fat than those from normal carcasses (Table 4). When the data were adjusted to a common grade fat (7.5 mm), similar results were obtained, with rib joints from DMx carcasses having 8.8% more ($P < 0.003$) muscle and 12.2% less ($P < 0.015$) fat than rib joints from normal carcasses. The results obtained for A2 carcasses were similar to those obtained for A1 carcasses, except that the magnitude of the differences between DMx and normal carcasses for each of these traits was different for A1 compared to A2 carcasses as illustrated in Fig. 1. At a constant grade fat, while the percentage difference in percent muscle between DMx and normal

Table 4. Least squares means and standard errors for dissected components of 10th-11th-12th rib joint of double muscle cross (DMx) and normal A1 and A2 bull carcasses

	No covariate				With covariate†			
	DMx	Normal	P‡	Percentage Difference§	DMx	Normal	P‡	Percentage Difference§
A1 carcasses								
No. of carcasses	28	12			28	12		
Muscle:fat	2.4±0.1	1.8±0.1	0.008	33.3	2.4±0.1	2.0±0.2	0.061	20.0
Muscle:bone	4.1±0.1	3.4±0.2	0.009	20.6	4.1±0.1	3.5±0.2	0.024	17.1
Percent fat	25.7±0.8	30.8±1.2	0.002	−16.6	25.8±0.7	29.4±1.2	0.015	−12.2
Percent muscle	59.5±0.8	53.2±1.3	0.001	11.8	59.4±0.8	54.6±1.2	0.003	8.8
Percent bone	14.7±0.4	15.9±0.6	0.138	−8.2	14.7±0.4	15.9±0.7	0.145	−7.6
A2 carcasses								
No. of carcasses	14	18			14	18		
Muscle:fat	1.7±0.1	1.6±0.1	0.262	6.3	1.7±0.1	1.5±0.1	0.087	13.3
Muscle:bone	4.0±0.2	3.4±0.1	0.008	17.6	3.9±0.2	3.3±0.1	0.005	18.2
Percent fat	31.9±1.2	33.2±0.9	0.394	−3.9	32.6±1.0	34.2±0.7	0.145	−4.7
Percent muscle	54.1±1.3	51.5±0.9	0.104	5.1	53.5±1.0	50.6±0.8	0.023	5.7
Percent bone	14.0±0.4	15.3±0.3	0.005	−8.5	13.9±0.4	15.2±0.3	0.007	−8.6

†Using grade fat as covariate; mean of 7.5 mm and 12.9 mm for A1 and A2 carcasses, respectively.
‡Probability of significance.
§[(DMx–normal)/normal] ×100.

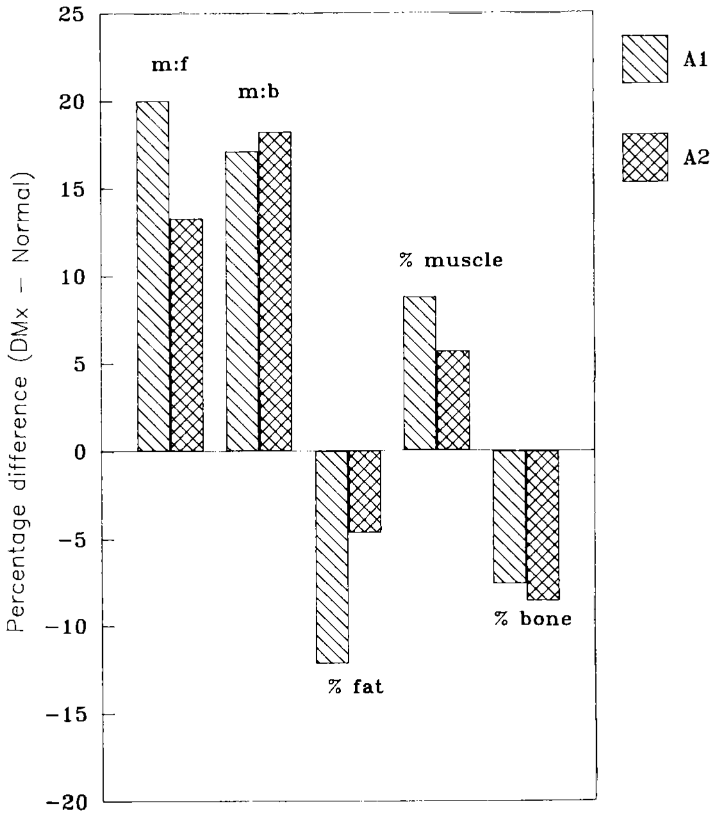

Fig. 1. Percentage difference in rib joint components between DMx and normal A1 and A2 carcasses.

carcasses for A1 carcass grade was 8.8 ($P < 0.003$), it was 5.7 ($P < 0.023$) for A2 carcass grade. It therefore appears that the magnitude of the advantage of DMx over normal carcasses in percent muscle is not the same across carcass grades, and that it seems to decrease with increase in fat thickness. This pattern has also been observed with regards to the advantage in percent muscle of steers over heifers in normal carcasses (Fredeen et al. 1981; Jones et al. 1987). This imples that if a premium price is to be paid for DMx carcasses, different rates should apply for different grades.

The current grading system in Canada is not designed to recognize carcasses within the same grade with superior lean yield. Heifer carcasses, however, are often discounted in price compared to steer or bull carcasses of the same grade. The difference between steer and heifer carcasses in lean content has been found to be about 2% for all carcasses and almost non-existent for A2 carcasses (Jones et al. 1987). If a difference in lean content of about 2% warrants difference in price between steer and heifer carcasses, then the 8.8 and 5.7% higher lean content (percent muscle) in DMx over normal carcasses grading A1 and A2, respectively, should command differential pricing.

Although the results obtained in this study were based on rib joint dissections, these rib joint dissections have been reported to adequately predict total carcass composition (Hankins and Howe 1946; Lunt et al. 1985). The degree of hypertrophy of muscles in DM animals is not uniform throughout the body (Vissac 1968; Hanset and Ansay 1972). Shahin and Berg (1985b), working with cattle from the same herd as used in this study, reported that muscles associated with the 10th-11th-12th rib joint were only moderately hypertrophied, hence they might be considered a good representative of the whole carcass in animals showing the DM syndrome.

There was significant ($P < 0.05$) year effect for some of the traits; however, no significant group by year interaction was obtained for any of the traits studied.

The results of this study indicate that DMx carcasses have higher lean yield than normal carcasses. The magnitude of the difference, however, differs across carcass grades, with the difference diminishing with increase in carcass fatness. With the increasing demand for leaner carcasses, it is probable that in the future, DMx carcasses will command a premium price as a reflection of their higher lean yield compared to N carcasses.

ACKNOWLEDGMENTS

Financial assistance provided in part by the Agricultural Research Council of Alberta through its ''Farming for the Future'' program is acknowledged. The cooperation of Gary Minchau and the staff of the University of Alberta ranch, and Inez Gordon and the University Meat Laboratory staff is acknowledged. Assistance provided by the Agriculture Canada graders is gratefully acknowledged.

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