Selection for beef quality traits

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ABSTRACT

Records on 24 146 Angus and 5 632 Hereford carcasses processed at Manawatu Beef Packers between March 1993 and August 1994 which had been evaluated for beef marbling standard (BMS), beef fat standard (BFS) and beef colour standard (BCS) were used to derive overall meat quality score. Overall meat quality score in the Japanese grading system is determined by the lowest grade from: semi-objective assessment for BMS, BFS and BCS; and subjective assessment for meat brightness, firmness and texture, fat lustre and quality. Subjective measures of meat and fat quality are not routinely recorded at this plant and therefore overall meat quality score could only account for the three recorded items. The majority of Angus and Hereford carcasses (84.0 and 82.9%) had an overall meat quality score of 1 (inferior) and no carcasses had score 5 (excellent). This study reports the effects of selection to improve Japanese overall meat quality score by single trait improvement of the three meat quality attributes. A change of one grade in BMS (or BFS) for Angus carcasses decreased the proportion of score 1 carcasses to 12.8% (or 74.7%) and improved overall meat quality score from an average of 1.17 to 1.96 (or 1.29). A change of one grade in BMS (or BFS) for Hereford carcasses decreased the proportion of score 1 carcasses to 16.1% (or 66.8%) and changed overall meat quality score from an average of 1.18 to 1.90 (or 1.35).

Selection based on a well-designed progeny test would take 5 (or 9) years to improve BMS (or BFS) by one grade. Biological factors introduce a lag of at least six years from the start of test matings until there can be widespread harvest of beef animals with improved meat quality. Selection for BMS can improve overall meat quality score more effectively and more rapidly than selection for other meat quality traits.

Keywords: Angus; Hereford; selection; marbling; fat colour; meat colour.

INTRODUCTION

Carcass suitability for the Japanese beef market is based on carcass yield and overall meat quality score (Anon, 1988). Overall meat quality score (classified as 1-5) is determined by: i). beef marbling, ii). meat colour and brightness, iii). firmness and texture of meat, and iv). colour, lustre and quality of fat. Overall meat quality score is determined by the lowest grade amongst the four quality characteristics.

The objective of this study was to describe the current distribution of Angus and Hereford carcasses according to overall meat quality score and to determine the relative benefits of three single trait selection options aimed at improving carcass quality based on Japanese grading criteria.

MATERIALS AND METHODS

Collection of carcass data

Manawatu Beef Packers routinely record beef marbling standard (BMS), beef fat standard (BFS) and beef colour standard (BCS) on prime beef carcasses. These records were summarised for 24 146 Angus and 5 632 Hereford carcasses processed between March 1993 and August 1994. Carcass quality assessments are made (following chilling of carcasses for 12-24 hours) at the intersection of the 11/12th rib by visual comparison to official standards using standard marbling chips and meat and fat colour chips. Subjective measures of meat brightness, firmness and texture, and fat lustre and quality are not routinely recorded at this facility, consequently overall meat quality score could only be determined from BMS, BFS and BCS.

BMS ranges from 1 (inferior-little or no visible marbling) to 12 (excellent- abundant marbling). BFS ranges from grade 1 (excellent-white colour) to 7 (inferior-dark yellow colour). BCS 3-5 is considered excellent (cherry-red) with 1-2 (light pink) and 6-7 (dark red) being inferior. Overall meat quality score was based on a 1 (inferior) to 5 (excellent) scale and was determined by the lowest grade from BMS, BFS and BCS (Table 1). Highest overall meat quality score was given to carcasses exhibiting abundant marbling, white fat and intermediate meat colour.

TABLE 1: Determinants of overall meat quality score.

Overall meat quality score	Grade		
	BMS	BFS	BCS
1 (inferior)	1	7	
2	2	6	1, 7
3	3, 4	5	6, 2
4	5, 6, 7	4	5, 3
5 (excellent)	8-12	1, 2, 3	4

The effect of a one grade improvement in each of BMS, BFS and BCS on the distribution of carcasses within each overall meat quality score was evaluated.

Predicting effects of selection for carcass characteristics

Selection was based on a progeny test to identify superior sires from bulls born within a 200 cow closed nucleus breeding herd (see Garrick 1993). Assumptions were that 80 year-

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ling bulls were test mated to commercial beef cows with resulting progeny slaughtered at 2 years of age and evaluated for BMS, BFS and BCS. Accuracy of selection (r_{TI}) for meat quality traits was assumed to be 0.8. For heritabilities of 0.2, 0.3, or 0.4, the number of progeny required to obtain an r_{TI} = 0.8 would be 35, 23 or 16, respectively.

A heritability of 0.3 was chosen for BMS which is similar to 0.27 obtained by Koots *et al.* (1994) from a review of published literature estimates. A heritability of 0.3 was assumed for BFS and BCS. Genetic standard deviations (σ_g) were derived from the above heritabilities and assumed phenotypic standard deviations of 2 grade units for BMS and 1 grade unit for each of BFS and BCS.

The top 3 of the 80 progeny tested sires were selected each year as sires within the nucleus herd. These three sires were mated in the nucleus herd in their first year, and two in the subsequent two years respectively. Genetic gain per year (ΔG/yr) was calculated using the equation $\Delta G = r_{TI}\, i\bar{\sigma}_g / L$ (see Blair and Garrick, 1994).

RESULTS

The 24 146 Angus carcasses evaluated had a mean carcass weight of 312.6 kg (standard deviation, s.d.= 31.9 kg) and mean subcutaneous fat depth of 8.9 mm (s.d.= 6.3 mm). The 5 632 Hereford carcasses had a mean carcass weight of 310.6 kg (s.d.= 31.6 kg) and mean subcutaneous fat depth of 9.3 mm (s.d.= 6.5 mm). Meat quality measurements for Angus carcasses are summarised in Table 2. The majority of Angus carcasses (97.8%) fell within the three poorest marbling grades (BMS 1-3) and 94.1% fell within the three poorest fat colour grades (BFS 5-7). The majority of Angus carcasses (82.2%) had good meat colour (BCS, 3-5) with the remainder having grade 6-7 which is considered too dark.

TABLE 2: Distribution of Angus grassfed beef carcasses according to Japanese quality criteria.

Grade	Beef marbling standard		Beef fat standard		Beef colour standard	
	Frequency	%	Frequency	%	Frequency	%
1	18030	74.7	0	0	0	0
2	4376	18.1	2	0	19	0.1
3	1277	5.3	45	0.2	19	0.1
4	323	1.3	1734	6.6	1339	5.1
5	99	0.4	10647	40.2	20391	77.1
6	25	0.1	9936	37.6	4255	16.1
7	14	0.1	4095	15.4	436	1.5
Mean	1.4		5.6		5.1	
s.d	0.7		0.8		0.5	

The distribution of Hereford carcasses for meat quality characteristics was similar to that for Angus. However, a lower percentage of Hereford carcasses than Angus (65.5 vs 74.7%) had the poorest marbling grade (BMS=1) and a higher proportion of Hereford carcasses (24.2 vs 15.4%) had the poorest fat colour grade (BFS=7). Mean BMS and BCS were the same for both breeds with mean BFS differing slightly (5.6 and 5.7 for Angus and Hereford respectively).

Average overall meat quality score for Angus carcasses was 1.17 and 98.7% of carcasses fell within the two poorest overall meat quality scores (1-2). The effect of a one grade improvement in each of BMS, BFS and BCS on overall meat quality score for Angus carcasses is shown in Table 3. Improvement by one grade in BMS or BFS for Angus carcasses would decrease the proportion of carcasses with overall meat quality score 1 (84%) to 12.8% or 74.7% respectively and improve mean overall meat quality score from 1.17 to 1.96 or 1.29 respectively. For Hereford carcasses, the average overall meat quality score was 1.18, 98.8% of carcasses had the two lowest overall meat quality scores, (1-2). Improving BMS or BFS by one grade improved overall meat quality score from 1.18 to 1.90 or 1.35 respectively and decreased the proportion of carcasses with overall meat quality score 1 (82.9%) to 16.1% or 66.7% respectively.

Improving BCS by one grade did not affect the proportion of carcasses within each overall meat quality score since BMS and BFS limited improvement in overall meat quality score and average BCS was near to the optimum.

GENETIC GAIN

Single trait selection using a well-designed progeny test, would result in genetic gain for BMS of 0.21 grade units per year. Single trait selection for either BFS or BCS would improve the selected trait by 0.1 units per year. That is, 4.7 years would be required to improve BMS and 9.4 years required to improve BFS and BCS by one grade unit respectively.

Single trait selection for BMS or BFS would require 6.5 years or 62.7 years to improve overall meat quality score by one unit respectively. The longer time interval required to improve overall meat quality score through selection for BFS being a consequence of both the lower rate of genetic gain for BFS, and BMS being the major limiting factor to overall meat quality score.

DISCUSSION

This investigation showed BMS and BFS should be included as traits in the selection objective when the goal of selection is to increase quality of beef as assessed by the Japanese beef grading system. Marbling would be a more important trait for selection aimed at improving overall meat quality score than fat colour since it was the major limiting factor in the determination of overall meat quality score.

Wright (1994), using data from Richmond-Pacific (Hastings), stated that BFS was the greatest constraint to meeting specifications for Japanese markets. This contrast with the present study may be due to different finishing environments (Manawatu as opposed to Hawkes Bay), different relative importance being placed on meat quality characteristics between the two studies or different measurement techniques. Selection for BMS improved overall meat quality score more effectively than selection for BFS or BCS alone. In practice, selection for carcass quality characteristics can be accomplished by undertaking progeny test or ultrasound measurements on live animals.

A long time (9.4 and 4.7 years) would be required to improve meat quality traits through single trait selection. The rate of genetic gain achieved may be optimistic due to high selection intensity resulting from selection of the top 3 from

TABLE 3: Effect of improvement by one grade for BMS, BFS and BCS for Angus carcasses on distribution of carcasses within each meat quality grade.

March 1993 – May 1994			Improvement of one grade in:					
			BMS		BFS		BCS	
Score	Frequency	%	Frequency	%	Frequency	%	Frequency	%
1 (inferior)	20287	84.0	3101	12.8	18030	74.7	20287	84.0
2	3539	14.7	19335	80.1	5259	21.8	3538	14.7
3	319	1.3	1704	7.0	851	3.5	320	1.3
4	1	0.0	6	0.1	6	0	1	0
5 (excellent)	0	0	0	0	0	0	0	0
Mean overall meat quality score	1.17		1.96		1.29		1.19	1.17

80 progeny tested bulls. Few registered breeders would have the ability to progeny test such a large number of yearling bulls. A decrease in accuracy of selection from 0.8 to 0.4 would increase the number of years required to improve BMS and BFS by one grade from 4.7 and 9.4 years to 7.5 and 14.9 years. If the breeder chose to retain the top 3 progeny tested bulls each year for breeding purposes, but tested only 20 bulls each year, the number of years required to improve BMS and BFS by one grade would increase from 4.7 and 9.4 years to 6.5 and 13.0 years respectively. In addition, a lag of at least 6 years would occur before there would be widespread benefit from these selection decisions in the commercial beef cattle industry.

Chadee and Mori (1993), noted that in addition to marbling, meat colour and meat firmness and texture are equally as important determinants of beef price in the Japanese beef market. Single trait selection strategies aimed at improving marbling may therefore result in little or no premiums received for the beef product due to other quality factors.

CONCLUSIONS

Both management during finishing and selection can be employed to improve meat quality traits of importance to the Japanese market. Both strategies should concentrate primarily on improving BMS and secondarily on BFS if improving overall meat quality score is financially rewarding for producers.

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