BEEF FROM DAIRY BREEDS VERSUS DAIRY X BEEF BREED CROSSES: A COMPARISON OF PRODUCTION FACTORS AND MEAT EATING QUALITY

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Abstract – The aim of this research was to quantify and have a better understanding of the differences in the eating quality of beef *(M. longissimus lumborum)* from dairy compared to dairy x beef breed crosses and to identify why such differences occur.

Nine replicates of six groups of cattle of mixed breed and sex: 100% Holstein (Hol x Hol) steers, 50/50 Holstein / Aberdeen Angus (Hol x AA) steers, 50/50 Holstein / Limousin (Hol x L) steers, and equal groups of 50/(25/25) Charolais / Holstein x Limousin (C x (Hol x L) steers and heifers were assessed.

Significant differences in production factors, striploin yields and meat quality were identified between the different breeds of cattle. Although pure Holstein steers had poorer confirmation, lower striploin weights and eye muscle areas than predominantly dairy x continental cross cattle, both Hol x Hol and Hol x AA beef received higher consumer panel scores for overall liking, aroma liking, flavour liking, juiciness and tenderness than the dairy x continental cross breeds.

A greater understanding of these factors could help develop breeding regimes which favour both yield and eating quality of Northern Ireland beef.

Key Words – Dairy beef, meat yield, meat quality and consumer panels.

I. INTRODUCTION

The Northern Ireland beef industry slaughters around 460,000 animals per year and makes a major contribution to the Northern Ireland economy. About 44% of these animals are derived from the dairy herd [1]. However, dairy beef is regarded by the industry as of lesser quality than that from beef breeds. Dairy beef gives a lower yield per animal and, because of this, is downgraded by the EUROP conformation system.

The genetic potential for beef production amongst pedigree dairy breeds selected for milk production was demonstrated in the USA many years ago [2] and production studies on such beef have since been successfully developed [3].

Although few studies have investigated the eating quality of beef from the dairy herd, it has been consistently shown [4-6] that the eating quality of beef from dairy breeds is as good as and often better than that from beef breeds. The reason for this is unclear and past research suggests that increased marbling is not the answer.

This study was designed to help explain why dairy beef has better eating quality and how this information may be used for the benefit of the Northern Ireland beef industry.

II. MATERIALS AND METHODS

Analyses were carried out on all 54 cattle (6 groups encompassing breed and sex, 2 locations and 9 replicates per group). Cattle were slaughtered in a commercial abattoir at normal finishing weight and age, the sides hung by the aitch-bone (tenderstretch) prior to chilling, and deboned following normal chilling protocols at 48h post-mortem. Carcase data and meat quality parameters were recorded as follows:

Production and carcase factors: carcase gain (kg/ day), age at slaughter (months), hot standard carcase weight (HSCW, kg), mean rib fat thickness (mm), weight of striploin (kg) and eye muscle area (cm^2).

Meat quality parameters: marbling score, intramuscular fat % (IMF), ultimate pH (pHu), sarcomere length (μm), Warner-Bratzler shear force (WBSF, kgF) [7] and colour (L*a*b* values), obtained from reflectance spectra of the freshly cut meat surface measured continuously

from 380nm to 800nm using a 0°/45° illumination viewing geometry head attached to a Monolight 6800 Spectrophotometer (Macam Photometrics, Livingstone, Scotland).

Striploin slices (25mm) were aged in vacuum packs at 0°C for 3, 7, 14, 21 and 28 days, then blast frozen and stored at -20°C prior to analysis and consumer panel assessment.– Eating quality was subsequently assessed on those samples of beef aged for 7 to 28 days. –The beef slices were thawed at room temperature prior to grilling in a Rotational oven at 170°C for approximately 9 minutes to an internal temperature of 78°C until cooked to 'just well-done'. –The cooked steaks were rested for two minutes on removal from the oven, then served to consumers for the assessment of aroma liking, flavour liking, tenderness and overall liking on a 0-100 line scale, where 0 is dislike extremely and 100 is like extremely. Satisfaction was scored on a 1 to 4 point scale where 1 is unsatisfactory, 2 is satisfactory everyday quality, 3 is better than everyday quality, and 4 is premium quality. The questionnaires were scanned using Biosystemes FIZZ software prior to statistical analysis. Data was analyzed by ANOVA[8].

Table 1. Production and carcase characteristics of dairy and dairy x beef breed cross cattle.

Farm	Sex	Breed	Slaughter age (Mo)	Carcase gain (Kg/day)	HSCW (Kg)	Mean Rib Fat (mm)	Rib Fat (mm) MSA	Wt Striploin (Kg)	EMA (cm^2)
H	S	Hol x Hol	24.5^{cd}	0.481^{bc}	358.9^{b}	5.42^{cd}	8.22^{bc}	8.37^{ab}	54.0^{a}
H	S	Hol x AA	24.6^{cd}	0.470^{b}	350.9^{ab}	5.97^{d}	9.25^{c}	8.98^{b}	55.7^{a}
H	S	Hol x L	23.9^{bc}	0.472^{b}	344.5^{ab}	5.02^{bcd}	6.88^{ab}	8.93^{b}	64.7^{b}
L	S	Hol x Hol	25.1^{d}	0.438^{a}	334.4^{a}	4.02^{ab}	7.37^{bc}	8.16^{a}	49.9^{a}
L	S	C x (Hol x L)	23.0^{a}	0.541^{d}	389.9^{c}	3.34^{a}	5.93^{a}	10.38^{c}	68.8^{b}
L	H	C x (Hol x L)	23.7^{ab}	0.504^{c}	353.1^{b}	4.23^{abc}	7.33^{abc}	10.19^{c}	67.7^{b}
		FPr	**<0.001**	**<0.001**	**<0.001**	**0.002**	**0.028**	**<0.001**	**<0.001**

Table 2. General meat quality characteristics of the loin muscles of dairy and dairy x beef breed cross cattle.

Farm	Sex	Breed	Marbling (units)	IMF (%)	pHu	SL (µm)	Mean WBSF (KgF)	L*	a*	b*
H	S	Hol x Hol	566^{d}	10.68^{c}	5.50^{b}	2.70^{ab}	4.12	37.8^{c}	24.9^{b}	14.3^{bc}
H	S	Hol x AA	504^{cd}	9.69^{c}	5.50^{b}	2.56^{a}	4.35	36.1^{bc}	26.1^{b}	12.2^{ab}
H	S	Hol x L	369^{ab}	4.58^{a}	5.51^{b}	2.78^{b}	4.78	36.2^{bc}	19.9^{a}	13.1^{ab}
L	S	Hol xHol	458^{bc}	6.97^{c}	5.39^{a}	2.87^{b}	4.46	33.7^{ab}	19.2^{a}	12.7^{ab}
L	S	C x (Hol x L)	327^{a}	3.59^{a}	5.59^{c}	2.81^{b}	4.16	32.0^{a}	25.1^{b}	15.8^{c}
L	H	C x (Hol x L)	307^{a}	3.54^{a}	5.60^{c}	2.85^{b}	4.64	32.9^{ab}	20.1^{a}	11.5^{a}
		FPr	**<0.001**	**<0.001**	**<0.001**	**0.029**	**0.065**	**0.018**	**<0.001**	**0.043**

Table 3a. Effect of breed on beef eating quality assessed by consumer panel

Farm	Sex	Breed	Consumer panel scores					
			Aroma	Tenderness	Juiciness	Flavour	O'all Liking	Satisfaction
H	S	Hol x Hol	61.6^{b}	61.1^{c}	60.9^{c}	63.2^{c}	64.1^{c}	2.67^{b}
H	S	Hol x AA	60.2^{b}	59.5^{bc}	59.9^{bc}	60.8^{bc}	61.1^{bc}	2.57^{b}
H	S	Hol x L	57.1^{a}	55.2^{ab}	51.8^{b}	55.2^{a}	56.1^{a}	2.36^{a}
L	S	Hol x Hol	61.9^{b}	61.2^{c}	59.1^{bc}	62.6^{bc}	63.1^{bc}	2.36^{a}
L	S	C x (Hol x L)	59.0^{a}	59.4^{bc}	55.9^{ab}	58.4^{ab}	58.7^{ab}	2.49^{ab}
L	H	C x (Hol x L)	57.2^{a}	53.9^{a}	51.9^{a}	54.3^{a}	55.2^{a}	2.31^{a}
		FPr	**0.003**	**0.043**	**<0.001**	**<0.001**	**<0.001**	**0.002**

Table 3b. Effect of ageing time (days) on beef eating quality assessed by consumer panel and WBSF of loin muscles.

Days aged	Consumer panel scores						WBSF
	Aroma Liking	Tenderness	Juiciness	Flavour liking	Overall Liking	Satisfaction	
3	-	-	-	-	-	-	4.62d
7	58.6	56.6^{a}	55.9	58.0^{a}	58.5^{a}	2.47^{a}	4.44c
14	59.1	57.0^{a}	55.5	59.3^{ab}	59.0^{a}	2.47^{a}	4.43bc

21	60.9	61.0[b]	58.3	61.1[b]	62.1[b]	2.61[b]	4.28a
28	59.4	59.0[ab]	56.7	58.0[a]	59.3[a]	2.49[b]	4.31ab
FPr	**0.171**	**0.004**	**0.147**	**0.030**	**0.013**	**0.020**	**<0.001**

Sex: S = steer, H = heifer.
Farm: **H** = Hillsborough, **L** = Loughgall.

III. RESULTS AND DISCUSSION

Tables 1- 3 list the production, general meat quality characteristics and consumer panel assessments of eating quality, respectively, of the six groups of dairy beef cattle studied.

Effects of breed on production and carcase parameters

Table 1 indicates that there were significant differences ($P < 0.05$) in all key production indicators, especially age at slaughter, carcase gain, HSCW, weight of striploin and eye muscle area ($P < 0.001$). Mean age at slaughter varied from 23 to 25 months, the pure Holsteins and Holstein x Angus crosses being slaughtered at slightly older ages than the other breeds. Likewise, pure Holstein, Holstein x Angus and Holstein x Limousin steers had the lowest carcase gains. The heaviest carcases were the Charolais x (Holstein x Limousin) steers, some 16% heavier than the pure Holstein steers reared at the same Loughgall farm. These Charolais x (Holstein x Limousin) steers also had the lowest rib fat thickness, and the highest striploin weight and eye muscle area. In contrast, the greatest difference in mean striploin weight was between pure Holstein steers and the Charolais x (Holstein x Limousin) steers reared at the Loughgall farm, the Holsteins being around 20% lighter. Likewise, pure Holstein eye muscle areas were approximately 27% lower than those of the Charolais x (Holstein x Limousin) steers and heifers reared on the Loughgall farm.

Effects of breed and ageing on meat quality measurements

Significant breed differences ($P < 0.05$) were found in all of the *M. longissimus lumborum* meat quality attributes other than shear force ($P > 0.05$), which nevertheless lay within the acceptable range of 4.12 to 4.78 kgF for cooked loin muscle (Table 2). Marbling and intramuscular fat followed similar trends, with the pure Holsteins and Holstein x Angus steers reared on the Hillsborough farm having the highest loin muscle fatness of around 10% compared to the very lean Charolais x (Holstein x Limousin) steers and heifers reared on the Loughgall farm.

Ultimate pH (pHu) values were normal, ranging between pH 5.4 and 5.6 across all groups of animals. Sarcomere lengths across all groups were well in excess of 2.00 μm, indicative of tenderstretch hanging. L*a*b* colour values between breeds were within the normal range found in well bloomed beef striploin.

Effects of breed and ageing on consumer acceptability

Consumer panel scores for eating quality showed significant breed differences ($P < 0.05$) for each attribute (Table 3a), in particular for juiciness, flavour and overall liking. The favoured breeds were the pure Holstein steers reared on both farms, and the Holstein x Angus crosses reared on the Hillsborough farm. The least favoured group was the Charolais x (Holstein x Limousin) heifers reared at the Loughgall farm. Significant ageing differences ($P < 0.05$) were found for all eating quality attributes apart from juiciness (Table 3b). Three weeks of ageing was the most preferable to consumers, giving the most satisfaction, a trend which mirrored the mean Warner-Bratzler shear force values.

IV. CONCLUSION

It has been shown that breed differences in eating quality are measurable between pure-bred dairy steers and dairy x beef cross-bred cattle. One of the major differences is related to the greater amount of intramuscular fat associated with the pure Holstein steers, a trait that was also found with Holstein x Angus cross steers. Differences

between breeds were also found for several meat quality characteristics although no significant differences in Warner-Bratzler shear force values were found.
Overall, the eating quality characteristics of all breeds were good, though consumer panels preferred the eating quality of pure Holstein and Holstein x Angus cross bred beef to all other crosses studied. Ageing for 21 days produced the most desirable eating quality across all breeds, a trend confirmed by differences in Warner-Bratzler shear force values.

These results confirm previous research by AFBI [4] showing consumer preference for dairy-bred beef. Although pure Holstein steers had poorer conformation, lower striploin weights and eye muscle areas than the dairy x continental cross groups, the pure Holstein and Holstein x Angus beef received higher consumer panel scores for overall liking, aroma liking, flavour liking, juiciness and tenderness than the other cross breeds.
The role of higher levels of intramuscular fat [9] and differential rates of formation of specific flavour precursors during ageing between these groups of cattle [10] may be key positive factors in explaining the improved eating quality of striploin from pure Holstein steers compared to that of the dairy x beef breed crosses.

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