EATING QUALITY OF BEEF FROM YOUNG DAIRY BULLS FROM TWO BREEDS AT THREE AGES FROM DIFFERENT PRODUCTION SYSTEMS

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Abstract –This study investigated the physico-chemical and sensory characteristics of beef from young male progeny of high genetic merit dairy cows - Holstein-Friesian (HF) and Jersey × Holstein-Friesian (JEX) - fed with pasture only or concentrate mixed with pasture during their first season and slaughtered at 16, 19, or 22 months of age. The *Longissimus thoracis et lumborum* (LTL) muscle was removed from 67 cube rolls. Ultimate pH, meat colour and intramuscular fat (IMF) content were evaluated. After ageing for 21 days, Warner-Bratzler Shear Force (WBSF) was measured and a trained sensory panel evaluation was conducted. The older animals had darker meat colour after 24h blooming, while pHu decreased with slaughter age and 'residual roast beef flavour length' increased with slaughter age. Meat from the JEX breed had relatively better colour than that from the HF breed. JEX samples were given higher sensory scores for greasiness and tended to have higher initial tenderness and metallic scores than HF samples. In summary, the eating quality of meat from the JEX breed was considered to be superior to that of the HF breed. The type of feeding in the first season had no significant effects on any of the meat quality traits.

Key Words – Colour, Texture, Sensory analysis, Young bulls

I. INTRODUCTION

The ending of the EU milk quotas is expected to lead to an increase in the Irish dairy herd which will result in a large increase in the number of male calves born. There is interest in rearing these as young bulls, provided profitable production systems can be developed and the meat quality is of an acceptable quality. There is limited information about the meat eating quality of young bulls from dairy breeds. Meat attributes such as colour, water holding capacity and tenderness can be affected by production systems including factors such as different breeds, feeding regimes, slaughter ages of animals and handling and exercise conditions [1]. This study aims to describe the physico-chemical and sensory characteristics of beef from two dairy breeds of young bulls reared in different production systems and slaughtered at three different ages. Moreover, a greater understanding of how these production systems (breed, first season feeding and slaughter age) affect dairy bull beef attributes would aid in further decisions on how meat from dairy bulls should be produced and marketed.

II. MATERIALS AND METHODS

Animals and experimental design

A total of 273 weaned spring-born male dairy calves (165 HF and 108 JEX, 10-12 weeks of age) were sourced by Teagasc, Johnstown Castle Research Centre in 2010. The young dairy bulls were slaughtered at 16, 19 or 22 months at a commercial meat plant. Meat samples were taken from 67 individual bulls for meat quality analysis. Among these, 33 bulls had been fed only on grass during the first season and the other 34 bulls had been fed grass plus 2 kg concentrates during the first season (i.e. May-Nov). The concentrate mix used was 80% barley, 14% soya, 4% molasses and 2% minerals. Therefore, the experiment was a 2 (genotype) × 3 (slaughter age) × 2 (first season feeding) factorial design, resulting in 12 groups with 5 or 6 animals per group.

Sampling procedures

On the killing day, pH and temperature of the LTL muscle at the 10th rib on the left side of each carcass were measured hourly for 8 hours. Carcasses were chilled at 4℃ for 24 hours. The LTL muscle was removed from the cube roll (ribs 6-10) from the left-hand side of each carcass at 48 h post mortem. Ultimate pH (pHu) of the LTL was measured at 72 h, and the muscle was cut into individual slices (2.54 cm thick). Colour was measured on the first slice from the 10th rib end and the remainder of the slices were vacuum-packed and IMF samples were stored at -20 ℃ directly, while samples for WBSF and sensory analysis were aged for 21 days at 4 ℃ and then frozen at -20 ℃ for further analysis.

Quality measurement

Freshly cut samples were wrapped in cling film and left to bloom at 4 ℃ for 24 h. Colour measurements were taken through the cling film at 5 locations on each sample and averaged using a HunterLab Ultrascan XE spectrophotometer (Hunter Associates Laboratory Inc., VI, USA). CIE L^* (lightness); a^* (redness) and b^* (yellowness) values were recorded. Hue angle = $(\tan^{-1} b^*/a^*)*57.29$, and Saturation index = $(a^{*2} + b^{*2})^{1/2}$ were calculated. IMF concentrations of thawed minced beef samples were measured using the NMR Smart Trac rapid Fat Analyser (CEM Corporation, USA).
Warner Bratzler Shear Force (WBSF) was determined on cores taken from steaks cooked in a water bath at 72 ℃ to a core temperature of 70 ℃ using an Instron Universal Testing Machine (Models 5543).
Sensory analysis was conducted according to the American Meat Science Association Guidelines [2]. Beef was heated on a double contact plate electric grill set at 230 ℃ until an internal temperature of 70 ℃ was reached. They were served to an eight member trained sensory panel. Each attribute was rated on a 100 mm unstructured line scale with 0 mm being equivalent to no attribute intensity and 100 mm being equivalent to the highest intensity.

Statistical Analysis

Each measurement was carried out for 67 individual muscles with two or three replicates per muscle, depending on the analysis. The data were analysed using the GLM procedure of ANOVA from the SAS software [3] with treatment (breed, age, first season and their interactions) as factors. Multiple comparisons were adjusted by the Tukey-Kramer test with a significance level of P<0.05.

III. RESULTS AND DISCUSSION

The type of feeding in the first season did not affect any of the variables so will not be considered further.

Physico-chemical analysis

Ultimate pH was significantly higher for 16 month old bulls, with a mean value of 5.73, while 19 and 22 month old bulls had similar mean pHu values of 5.55 and 5.57, respectively (P<0.001) (Table 1). The pHu did not differ between breeds. Mean pHu values of all groups ranged from 5.53 to 5.74 (data not shown), which is within the range considered normal for beef and veal of 5.4≤pHu≤5.7 [4]. No DFD (dark, firm, dry, pHu >6.0) meat was recorded.

CIE L^* decreased (meat became darker) with slaughter age (P<0.001) (Table 1), which is in agreement with Page *et al*., [5], who found that meat from older animals is darker than meat from younger animals. In the present study JEX meat was darker (lower L*) than that from the HF breed (P<0.05). HF meat tended to have higher b* values than JEX meat (P<0.10), while Hue angle was also higher in HF meat (P<0.01). The increase in Hue angle and b* of HF meat compared to JEX meat indicated a greater degree of browning for HF meat.

Mean IMF content in all groups ranged from 2.02% to 4.44% (data not shown), which was within the range from 0.45% to 6.65% reported by Waritthitham *et al.*, [6] for beef breeds. The average IMF content of the LTL muscle observed here was low (<5%), in agreement with Riley *et al*., [7]. An IMF level of about 3.25% was defined as a grade with a ‘slight degree of marbling', which was found to be preferred by US consumers on visual quality and marbling degree. Most (47%) Swiss consumers preferred beef with 3-4% IMF, whereas 27% selected beef with no visible marbling [8]. The IMF level of most dairy bull beef in the present study at ≧3% was in the acceptable range of consumers' purchasing decisions.

WBSF of the LTL muscle after ageing for 21 days varied from 17.4 N to 46.1 N (data not shown). Only 3 samples had WBSF values above 40 N and hence could be considered 'intermediate' tough (38.22 N<WBSF<45.08 N), all other samples were either 'very tender' (WBSF<31.36 N) or 'tender' (31.36 N<WBSF<38.22 N) [9]. Therefore, the LTL from HF and JEX breeds in the present study was considered tender after 21 ageing days. Dairy bulls aged 16 months did not produce more tender meat than 19- and 22-month old bulls which is not in agreement with Dransfield *et al.*, [10], who found that meat from 15-month old bulls was more tender than that from 19-month or 24-month old bulls which had similar tenderness. The lack of an effect of age in the present study may be due to the extended post-mortem ageing of 21 days. It was shown by Jurie *et al.*, [11] that differences in WBSF between breeds disappeared after 14 days of ageing.

Table 1 Least square means of physico-chemical quality traits of young dairy bull beef

	Age (month)			Breed		S	
	16	19	22	HF	JEX	A	B
pHu	5.73^{a}	5.55^{b}	5.57^{b}	5.62	5.61	***	ns
L* 24h	45.2^{a}	43.4^{b}	42.0^{b}	44.3^{a}	42.8^{b}	***	*
a* 24h	17.6^{a}	15.7^{b}	17.5^{a}	16.7	17.2	**	ns
b* 24h	14.0^{a}	12.1^{b}	13.4^{a}	13.5	12.8	***	ł
H24h	38.6	37.7	37.4	39.0^{a}	36.8^{b}	ns	**
S24h	22.5^{a}	19.8^{b}	22.0^{a}	21.5	21.4	**	ns
WBSF	29.6	29.8	27.7	28.4	29.6	ns	ns
IMF (%)	2.76	3.34	3.26	3.08	3.15	ns	ns

S = Significance: ns = P>0.1; ł = P ≤0.1; * = P ≤0.05; ** = P ≤0.01; *** = P ≤0.001.

A = age; B = breed. pHu = ultimate pH; WBSF = Warner-Bratzler Shear Force; IMF = Intramuscular fat. H= Hue angle. S= Saturation.

Sensory analysis

With increasing age, residual roast beef flavour length increased (P<0.05) and roast beef aroma tended to increase (P<0.10) (Table 2). This was expected as Lawrie [12] reported that flavour intensity is known to develop with increasing age of animal. Intensity of greasiness was higher in JEX than in HF (P<0.05). Also JEX meat tended to have higher initial tenderness and metallic scores than HF meat (P<0.10). Despite the extended ageing period of 21 days, the rancid flavour in our study was low (<5), which is not surprising since the samples were intact and kept under vacuum during storage [13].

Table 2 Least square means of sensory attributes of young dairy bull beef

	Age (month)			Breed		S	
	16	19	22	HF	JEX	A	B
Roast Beef Aroma	56.5	63.7	60.0	58.5	61.7	ł	ns
Initial Tenderness	72.7	69.4	69.5	67.4	73.6	ns	ł
Juiciness	51.0	48.8	41.0	44.3	49.5	ns	ns
Cohesiveness	53.4	56.2	52.7	55.1	53.1	ns	ns
Chewiness	29.5	34.4	31.1	32.6	30.7	ns	ns
Greasiness	15.1	14.5	14.7	13.0^{b}	16.5^{a}	ns	*
Stringy	11.5	15.0	15.0	15.5	12.2	ns	ns
Roast Beef Flavour	54.0	57.0	56.6	54.2	57.5	ns	ns
Metallic	12.8	17.5	16.3	13.0	18.1	ns	ł
Rancid	3.45	4.94	4.13	3.55	4.80	ns	ns
Res-RBFL	47.9^{b}	50.7^{ab}	55.1^{a}	49.9	52.6	*	ns
Res-Fattiness	16.7	17.5	16.4	16.1	17.6	ns	ns

S = Significance: ns = P>0.1; ł = P ≤0.1; * = P ≤0.05; ** = P ≤0.01; *** = P ≤0.001.

A =age; B =breed; Res = residual effect after swallowing; RBFL = Roast Beef Flavour Length

IV. CONCLUSION

The eating quality of beef from these young dairy bulls was generally good. Only three of the samples had a WBSF score above 40 N indicating that most beef samples were acceptably tender after 21 ageing days. Some eating quality attributes were affected by breed and age at slaughter but type of feed in the first season did not affect any attributes. Crossbreeding Jersey with Holstein-Friesian might improve the eating quality of young dairy bulls. However, the effects on colour could be important in sorting carcasses for different markets, with JEX meat being less suitable for markets preferring lighter beef. Based on these results good quality beef can be produced from young dairy bulls at least up to 21 months of age.

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