Q204X MYOSTATIN MUTATION EFFECTS ON CARCASS AND MEAT QUALITY TRAITS IN HETEROZYGOUS CHAROLAIS YOUNG BULLS

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Introduction

Double muscling in cattle is known to be controlled by mutations in the myostatin gene (Grobet *et al.*, 1998). Homozygous cattle with two copies of the mutated allele have a dramatically enhanced muscle development (Ménisier, 1982). Except in few breeds (Belgian Blue, Piedmontese) the double-muscled animals are generally discarded for replacement breeding due to the adverse effects on maternal traits. Nevertheless, the selective superiority of heterozygous animals may lead to the maintenance of a significant frequency of the myostatin mutations in some breeds. The availability of molecular tests allows the detection of the different mutations (Fahrenkrug *et al.*, 1999; Miranda *et al.*, 2002) that are segregating in these populations and consequently the estimation of the allele frequencies and/or the genotype effects on meat production traits. In a sample of 128 purebred cows Dunner (2001) estimated the frequency of the Q204x mutation (specific of the Charolais) to 16% in the French Charolais breed. In experimental crossbred populations Short *et al.* (2002) and Casas *et al.* (2004) estimated the effects of the C313Y and nt821 mutations (specific of the Piedmontese and Belgian Blue respectively) on live and carcass traits. The objective of the present study was to evaluate the frequency of the myostatin Q204x allele in the French Charolais breed and to evaluate its effect on live, carcass and meat quality traits when comparing heterozygous carriers with normal homozygous cattle.

Materials and Methods

In France, artificial insemination sires of the specialized beef breed are progeny tested for estimating breeding values of live and carcass traits. Four hundred and eight male calves, randomly procreated in pure bred Charolais herds by 22 Charolais sires, entered two feed lots in 2003, were fattened with corn silage and eventually were slaughtered in two slaughter houses when they reached 728 kg live weight on average. In addition to the carcass traits usually recorded (dressing percentage, fat and muscling scores) meat quality attributes and related muscle characteristics were also recorded. Twenty four hours post slaughter, a 6th to 9th rib section was excised. Muscle lightness was measured on the *Longissimus thoracis* surface. The rib eye area and the ratio of fat to muscle + fat weights in the dissected 6th rib were measured. Steaks sliced in the *Longissimus thoracis* muscle were placed for a 14 day ageing period and then frozen. Meat texture was evaluated by the measurement of Shear Force with a Warner-Bratzler device. For meat quality measurements, thawed steaks were cooked on a grill with a core temperature of 55°C, which is the usual cooking temperature for beef meat in France. Sensory attributes (Tenderness, Juiciness and Flavour) were measured by 12 trained panellists. Three muscle characteristics related to meat quality were also measured on muscle samples 24 hours post mortem: collagen (assessed via hydroxyproline), lipid (assessed via ether extract) contents and muscle fibre section mean area.

Blood samples were obtained from all the bull calves and sires, and most (n=326) of the dams. DNA was extracted and genotyped for the Q204x mutation (TaqMan 5' nuclease assay, 7900 HT Applied Biosystems). Two genotypes were found: homozygous (+/+) or heterozygous (+/mh). According to the sire and dam genotypes, the sire inherited allele (al_s = + or al_s = mh) was determined unless the three animals were heterozygous (al_s = ?).

The base model for analysing the performance included the feed-lot/slaughter house (F) fixed effects and the sire (s) random effects. For estimating the allele substitution effect, the sire inherited allele effect, pooled within sire (al_s(s)), was added to the base model. For estimating the average additive genetic effect (a), the calves' genotype (+/+ or +/mh) effect was added to the base model and (a) was computed as the difference between the heterozygous minus the homozygous calf effects.

Results and Discussion

Among the 22 sires, 7 (32%) were heterozygous for the Q204x mutation while 52 among the 326 genotyped cows were heterozygous (16%). The cow sample being more highly representative of the whole breed variability, the Q204x allele frequency in the French Charolais breed can be estimated to 9%.

Among the 138 calves from the 7 heterozygous sires, 68 inherited the a_s=+ and 40 the a_s=mh allele. For 30 calves, it was not possible to determine which allele was transmitted by the sire however. The substitution effects on the carcass muscling score averaged +1.05 standard deviation (P<0.001), ranking from 0.2 to 1.8 across sires.
Among the 408 calves, 86 were heterozygous, inheriting the mh allele either from the sire (n=40) or the dam (n=22). The origin of the mh allele could not be determined in 24 calves. The difference in carcass muscling score between calves with (+/mh) genotype and calves with (+/+) was estimated to **a**=+1.11 standard deviation (P<0.001), i.e. exactly the same estimate as the within sire substitution effect as expected for a causal mutation. The additive genetic effect (a) of the mutated allele was estimated and results are reported in the Table 1.

Table 1.

Trait		mean	± SD°	a =+/mh - +/+	a / SD	Prob[diff]
Dressing Percentage	%	57.7	1.9	1.9	0.98	<0.001
Muscling Score	/16	10.0	1.7	1.9	1.07	<0.001
Rib Eye Area	cm²	51.8	8.3	5.5	0.66	<0.001
Fat / (Fat+Muscle)	%	20.6	3.9	-3.0	-0.77	<0.001
Lipid content	%	1.62	0.96	-0.45	-0.46	0.001
Collagen content	%	0.38	0.07	-0.03	-0.40	0.005
Fibre Diameter	µ²	2824	678	-274	-0.40	0.003
L*	/100	35.8	4.7	2.1	0.43	0.001
Shear Force	kg	3.91	0.79	0.04	0.05	0.69
Tenderness	/100	62.2	8.6	2.2	0.26	0.06
Juiciness	/100	60.1	6.3	0.3	0.05	0.74
Flavour	/100	55.1	5.4	-0.5	-0.08	0.54

For the carcass composition and conformation, the effect of the mutated allele is important and of similar magnitude as the Piedmontese C313Y or Belgian Blue nt821 effects estimated by Short *et al.* (2002) and Casas *et al.* (2004). While no effect could be detected on Flavour, Juiciness and Shear Force, the presence of the Q204x has large effects on muscle characteristics: less lipids, less collagen, thinner muscle fibres. The mutated allele also gives lighter meat which tends to be tender.

Conclusions

A first estimation was obtained on the actual effect of the Q204x mutation inheritance on the carcass and meat quality of heterozygous Charolais in a population of commercial beef bulls. These effects are large enough to anticipate that genotyping of this mutation could allow breeders and/or producers to provide the market with beef cattle that fit part of the retailer or consumer requirements. Knowing the actual genotype of beef cattle may generate, therefore, an added value in comparison to the present situation where heterozygous cattle are marketed in the same market segment as normal homozygous cattle.

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