# Breeding for improved product quality

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**Summary**

- Considerable genetic variability exists within and across breeds for both milk quality and meat eating quality.
- Publicly available sire genetic evaluations now exist for offspring meat eating quality.

## Introduction

Consumer desires for safe, nutritious, healthy, and tasty products are intensifying. While management techniques such as grass-fed versus total mixed ration diets can influence milk quality and composition, and some post-mortem treatments of animal carcasses can influence the quality of meat products, breeding is a technology proven to deliver year-on-year cumulative and permanent gains for a range of performance traits. Accurate measurement of product quality, however, is resource intensive contributing to a large associated cost and generally slow throughput. Hence, identifying tools that can predict product quality has benefits, especially if that technology can provide additional insights into other features of the product or the animal itself.

## Milk quality metrics

The Irish national Economic Breeding Index (EBI) has enabled genetic selection for economically important milk quality parameters (fat, protein and somatic cell count), but far more granular measures of milk quality exist. These can relate to properties affecting milk processing characteristics, nutritive value (amino acid concentration), and appearance (colour) of milk. Genetic differences exist among cows in the type of milk they produce. In fact, some milk quality attributes are attributable to only a single or a few DNA variants, which are now routinely genotyped in Irish cows. The proportion of variation in milk protein fractions due to differences in genetics range from 0.05 (β-casein) to 0.69 (β-lactoglobulin B); the equivalent metric for free amino acids range from 0.08 for Glycine to 0.29 for Aspartic Acid. Variability in milk colour traits due to genetics varies from 0.07 to 0.35. Regarding milk processing attributes, the proportion of variation due to genetics ranges from 0.16 (heat coagulation time) to 0.43 (curd firming time). Many of these traits can be predicted using a technology called mid-infrared spectroscopy (MIR), which is already used globally to predict the fat, protein and lactose concentrations in milk. Previous Moorepark research has demonstrated that MIR can also predict the energy status of the cow, potentially how much methane she is producing, and even differentiate the milk of cows fed grazed pasture versus a total mixed ration. Because MIR data are already being generated for each milk sample collected for milk recording purposes in Ireland, it is possible to generate genetic evaluations for these metrics.

The DNA information now available has also been used to quantify the incidence of different variants of milk proteins like β-casein; the most common β-Casein variants of interest are A1 and A2. These variants have different properties, which can influence milk processing, and are often perceived to influence human health. The majority of Holstein-Friesian cows in Ireland carry one copy of each of the A1 and A2 variants, and these cows produce a mixture of A1 and A2 milk. Conversely, 42.4% of Holstein-Friesian cows have two copies of the A2 variant, and thus produce only pure A2 milk (Table 1). Furthermore, a greater proportion of Jersey cows produce pure A2 milk (64.5%) compared with Holstein-Friesian cows (Table 1).

**Table 1.** *The frequency (%) of A1 and A2 β-casein type genotypes in different dairy breeds using recent Irish data*

| Genotype | Holstein-Friesian | Jersey | Montbeliarde |
|---|---|---|---|
| A1A1 | 12.9 | 4.5 | 16.1 |
| A1A2 | 44.7 | 31.1 | 46.2 |
| A2A2 | 42.4 | 64.5 | 37.8 |

## Potential to breed for better meat eating quality

Ireland boasts one of the largest meat sensory databases globally, with tenderness, juiciness, and flavour information recorded for beef steaks from over 7,100 Irish prime cattle, and all animals also have DNA genotype information. Through research conducted using this large database, the Irish Cattle Breeding Federation (ICBF) launched the world's first multi-breed genomic evaluations for meat eating quality in September 2020. The proportion of the observed differences between individuals attributed to genetics is 0.16 for tenderness, 0.14 for juiciness, and 0.11 for flavour. Significant variation exists in these quality attributes both within and across breeds (Figure 1). For example, the meat from Angus-sired progeny is expected, on average, to be of superior quality (higher breeding value) than the meat from Charolais-sired progeny (lower breeding value). On the other hand, some Charolais sires produced progeny with meat of superior eating quality than some (poor) Angus sires. Research is ongoing on the incorporation of genetic merit for meat eating quality into the national breeding indexes.

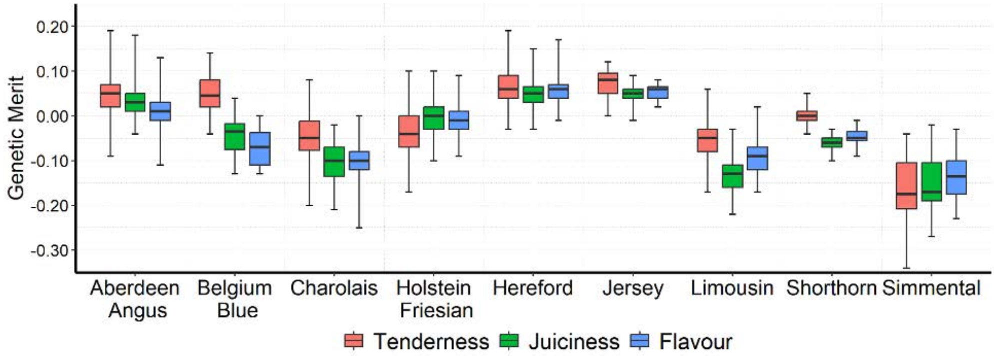


**Figure 1.** *Box and whisker plots of genetic merit for tenderness (red), juiciness (green), and flavour (blue) for different sire breeds. For each trait within breed, 50% of sires values are inside the box, the horizontal line indicates the median value, and the whiskers outside the box indicate the top and bottom 25% of sire values*

## Conclusions

Maintaining excellent product quality is essential to retain customer loyalty, and for gaining a foothold in future markets for Irish produce. The necessary tools and information now exist to make permanent and cumulative gains in milk and meat quality through breeding.