

DNA-Based Markers and Their Use in Dairy Breeding Programs

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Dairy producers are familiar with the use of DNA-based tests to determine whether animals are susceptible to certain diseases such as BLAD and DUMPS. DNA for analysis can be extracted from any tissue including blood, hair and semen. The explosion of genetic information and sequence data over the past decade has resulted in the recent availability of some DNA-based tests for production traits such as milk yield. These tests are based on research studies showing that specific DNA variations are associated with a positive effect on production traits such as milk yield. This now makes it possible to consider using “marker-assisted selection” in breeding decisions. Marker-assisted selection is the process of using the results of DNA testing to assist in the selection of individuals to become parents in the next generation. The word “assisted” implies that the selection is also influenced by other sources of information, such as PTAs (predicted transmitting ability) and Net Merit. The genotypic information provided by DNA testing should help to improve the accuracy of selection and increase the rate of genetic progress by identifying animals carrying desirable genetic variants for a given trait at an earlier age.

A DNA-based test called Igenity™ L (<http://www.igenity.com>) based on research out of Canada has recently been released by Merial. This is the first commercially available genetic test for a complex trait such as milk production. This test analyzes a small fragment (one base pair) of the DNA sequence of a gene called Leptin. Leptin (from the Greek *leptos*, meaning thin) is a protein hormone with important effects in regulating body weight, metabolism and reproductive function. Leptin concentrations are low in people and animals with low body fat, and leptin appears to be a significant regulator of reproductive function (1). Different forms of this gene, called genetic variants, have been reported to have an effect on milk yield and feed intake in dairy cattle. This is the first commercially available DNA-based test for dairy producers that influences a complex trait such as milk production.

Animals can have one of three results or “genotypes” (TT, TC or CC) for the leptin genetic variant that is analyzed in the Igenity™ L test. There is one published study showing an association between these leptin genotypes and both milk yield and SSC linear score (2). This Canadian study looked at DHI records from 416 Holstein cows from 11 Saskatchewan herds (mean herd size 71, mean milk yield 67 lb/day). Animals with the TT genotype produced more milk (3.3 lb/day) than animals with the CC genotype. The TC genotype was intermediate (2.0 lb/day). The increase in milk yield was most prominent in the first 100 days of lactation. The TT cows were additionally found to have a significant increase in the SSC linear score. The authors also reported a trend towards a small increase in protein yield (0.09 lb/day) in the TT cows, relative to the CC cows. In this Canadian study the frequency of the T form of the gene in Holsteins was 0.46, suggesting approximately 21% of the animals were TT. No studies examining the gene frequency or milk yield effect of these leptin genotypes in the US dairy population have been reported. The cost of the test is ~\$60/animal and it requires the collection of a hair sample (including the root bulb) from animals that are to be tested. The website for the supplier of the Igenity™ L test is <http://www.igenity.com>.

It is important to realize that DNA-based tests for complex traits like milk yield are associated with only one of the many genes that contribute towards milk production. They should not be regarded as telling you whether an animal has “the gene” for higher milk production. The presence or absence of the numerous other “unmarked” genes and the production environment will determine whether an animal actually makes more milk. Even in the presence of marker data, PTAs (predicted transmitting ability) should still be an integral component of selection decisions as they estimate the breeding value of all the “unmarked” genes that contribute to a given trait. Marker-assisted selection should be seen as a tool to assist with, and not as a replacement for, traditional selection techniques based on PTAs and Net Merit. Of course DNA-based tests are not a silver bullet, and in the end only a good production environment and management will allow a genetically-superior animal to live up to her genetic potential and produce more milk.

1. Liefers, S.C., Veerkamp, R.F., te Pas, M.F., Delavaud, C., Chilliard, Y., and van der, L.T. (2003). Leptin concentrations in relation to energy balance, milk yield, intake, live weight, and estrus in dairy cows. *J Dairy Sci.* 86, 799-807.

2. Buchanan, F.C., Van Kessel, A.G., Waldner, C., Christensen, D.A., Laarveld, B., and Schmutz, S.M. (2003). Hot topic: an association between a leptin single nucleotide polymorphism and milk and protein yield. *J Dairy Sci.* 86, 3164-3166.