

**GENOTYPE FREQUENCIES FOR GENESTAR<sup>®</sup> MARBLING – A DNA-BASED  
DIAGNOSTIC TEST FOR BEEF CATTLE.**

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**SUMMARY**

Results from over 1500 GeneSTAR<sup>®</sup> Marbling tests on cattle mainly from Australia, but also from Japan, Argentina, Canada and USA were used to estimate gene frequencies for GeneSTAR<sup>®</sup> Marbling. The frequency of animals homozygous for the favourable (high marbling) allele (2-STAR) was 9% in Angus cattle. Amongst Red Angus 16% were 2-STAR and in Wagyu 38% were 2-STAR. In other breeds the frequency of homozygotes averaged 2%. Differences in breed frequency and consequent approaches to selection for GeneSTAR<sup>®</sup> marbling are discussed.

**Keywords:** Marbling, Genotype frequency, beef cattle.

**INTRODUCTION**

In July 2000 GeneSTAR<sup>®</sup> Marbling was launched as a new DNA marker test for commercial use by Australian beef producers. It is believed that this may be the first test of its type to be commercialised, in that the resulting genotypes can be incorporated in the formalised breeding objective of a herd. The diagnostic test, GeneSTAR<sup>®</sup> Marbling, tests for variation in the thyroglobulin gene. The marker is in the promotor region 5' to the thyroglobulin gene. It has been shown in a research project conducted by CSIRO (Barendse 1997), with financial support from Meat and Livestock Australia (MLA), to be associated with higher marbling score in beef cattle. They were steers fed predominantly grain rations for more than 200 days and subsequently slaughtered for export to Japan.

This paper reports on current testing results providing summaries on over 1500 mostly Australian animals tested to date. The paper also indicates the path and potential outcomes of some of the research, development and commercialisation of gene markers for the beef cattle industry.

**MATERIALS AND METHODS**

The GeneSTAR<sup>®</sup> marbling test is a PCR-based RFLP (Restriction Length Fragment Polymorphism) test developed by CSIRO (W. Barendse pers. comm.) that discriminates between two sequence variants at the marker locus.

Table 1 shows breed genotype frequencies from commercial testing. Breed results are shown where more than 100 samples have been tested. Where less than a hundred tests have been performed in a breed, results have been included in 'others'.

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\* GeneSTAR is a registered trademark of Genetic Solutions P/L

For simplicity in reporting, the results are shown as 2-STAR, 1-STAR or 0-STAR indicating the number of copies of the favourable (high marbling) allele detected.

Virtually all samples tested are from seedstock cattle and the majority are from bulls. Although samples can be collected from blood, tissue, hair follicles or semen, samples described in this report were generally hair follicles obtained from the tail.

## RESULTS AND DISCUSSION

The frequencies of genotype and allele by breed from commercial testing are shown in Table 1. The frequency of 2-STAR animals, homozygous for the favourable allele varies between breeds. This is significant for two reasons. Firstly, the effect has been shown to be largely recessive in the data presented so far (Dr W. Barendse pers. comm.). Secondly, it is the frequency of 2-STAR bulls that tends to be the rate-determining step in selection to increase the frequency of the favourable allele.

**Table 1 Marker genotype and allelic frequency by breed for GeneSTAR Marbling**

Breed	Genotype			Allelic Frequency
	0	1	2	
Red Angus	42%	42%	16%	37%
Angus	53%	38%	9%	28%
Japanese Black Wagyu	12%	50%	38%	63%
Others	75%	23%	2%	14%
Overall	42%	40%	18%	38%

The breed with the highest frequency of 2-STAR animals is Japanese Black Wagyu, a breed which has been selected strongly for marbling based on progeny testing using classified carcass data. Inbred lines predominate in the breed (Takayanagi *et al.* 1996) which may also have led to a more rapid increase in frequency of homozygote 2-STAR animals. The majority of the remaining breeds are similar showing low frequencies of 2-STAR animals. The exception is the Red Angus breed, which is intermediate in frequency between the Wagyu breed and others.

Coordinated testing within major beef breeds could help to establish breed frequencies that could be taken into consideration in breed improvement programmes and genetic evaluations.

Knowledge of the gene frequency is important for breed improvement and for future matings. Segregation analysis tools are being developed to assist breeders to reduce costs of testing by calculating genotype probabilities and predicting which animals should be tested to yield most information (Macrossan *et al.* 2001).

The recessive nature of GeneSTAR<sup>®</sup> Marbling raises important extension issues for breeders unaccustomed to this mode of inheritance. New tools are required to assist breeders to incorporate results of this test with other sources of genetic information such as EBVs (Estimated Breeding Values) or EPDs (Expected Progeny Differences) for IMF% (Intra-Muscular Fat %) from ultrasonic real-time scanning.

Integration of genotypic information from DNA markers into genetic evaluation systems like BREEDPLAN (Nicol *et al.* 1985) will improve the efficiency of selections for breeders. The current version of BREEDPLAN cannot use this type of marker information in EBV calculation.

The integration of this technology requires both technical and logistical changes in national performance recording schemes. Breed associations have an opportunity to enable routine testing as part of their services. This will have the added benefit of monitoring the selective use of genotyping within the breed. The breed associations own the breed pedigree and performance databases. They can promote the use of analytical technology for the estimation of breeding values that incorporates effects of gene marker tests. Strategies for collection and storage of marker data plus methods of incorporating these data into new analytical models for BREEDPLAN are being researched currently (H.-U Graser pers. comm.).

Although this technology is in its infancy, research is being conducted by Genetic Solutions and others on a wide variety of traits with the objective of developing markers that can be used without reference to pedigree information in the same way as the GeneSTAR<sup>®</sup> Marbling test. Thus, in the near future further marker-based tests for marbling and other carcass traits will be available and will be able to be used by breeders in making selection decisions.

Further developments will include multi-gene tests that combine a range of traits. These will allow lot feeders, backgrounders and grass finishers to be selective in purchasing animals targeted at specific market and production systems.

Association of GeneSTAR<sup>®</sup> Marbling genotypes with marbling and other characteristics is also being evaluated for a variety of breeds and in various production systems. The results of this research will enable breeders to have greater confidence in the likely effect of using this test to help in animal selection and mating.

#### **REFERENCES**

- Barendse, W. (1997) Assessing lipid metabolism, Patent Application WO9923248 (PCT/AU98/00882).
- Nicol, D.C., Graser, H-U., Tier, B. and Hammond, K. (1985) *Proc. Aust. Assoc. Anim. Breed. Genet.* **5**: 151.
- Takayanagi, S., Moriya, K., Nomura, T., Dohgo, T. and Sasaki, Y. (1996) *Anim. Sci. Technol. (Jpn)* **67**: 286.
- Macrossan, P., Kinghorn, B.P. and Davis, G.P. (2001) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **14**: 309.

