

National Beef Cattle Evaluation Consortium

Commercial Genetic Test Validation

IGENITY Tenderness:

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Summary:

Igenity profile Tenderness is a DNA genetic marker panel test comprised of three markers (UoGCAST1, Calpain 4751 and Calpain 316). An increase in “tenderness” is associated with substituting a “C” allele at calpastatin (UoGCAST1) and a “C” allele at both μ -calpain loci (Calpain 4751 and Calpain 316). The following table shows the decrease in “toughness” (Warner-Bratzler Shear Force, lb) for each of the possible genotypes contrasted to the least tender genotype (i.e. UoG-Cast1 “GG”, Capn4751 “TT”, Capn316 “GG”) calculated from a combined analysis of 1209 cattle from four sample populations (Brangus, Charolais x Angus cross, Red Angus and Brahman) used in the validation study.

Genotype			Estimate (lbs.)	Standard Error	Number Obs.	%
UoG-Cast1	Calpain 316	Calpain 4751				
CC	CC	CC	-2.3	0.4	18	1.5
		CT	-1.1	0.6	8	0.7
		TT	0.1	1.0	0	0.0
	CG	CC	-1.9	0.3	60	5.0
		CT	-1.5	0.3	123	10.2
		TT	-0.4	0.5	9	0.7
	GG	CC	-1.6	0.3	60	2.7
		CT	-1.2	0.3	181	15.0
		TT	-0.8	0.2	212	17.5
CG	CC	CC	-1.9	0.3	9	0.7
		CT	-0.7	0.5	1	0.1
		TT	0.5	1.0	0	0.0
	CG	CC	-1.5	0.2	42	3.5
		CT	-1.1	0.2	74	6.1
		TT	0.1	0.5	4	0.3
	GG	CC	-1.2	0.3	23	1.9
		CT	-0.8	0.2	91	7.5
		TT	-0.4	0.1	204	16.9
GG	CC	CC	-1.4	0.3	2	0.2
		CT	-0.2	0.5	1	0.1
		TT	1.0	1.0	0	0.0
	CG	CC	-1.1	0.2	7	0.6
		CT	-0.7	0.1	9	0.7
		TT	0.5	0.5	0	0.0
	GG	CC	-0.8	0.3	5	0.4
		CT	-0.4	0.1	30	2.5
		TT	0		63	5.2

The yellow shaded genotypes involve the rare "T-C" haplotype. The low number of animals with this genotype in the data set made it difficult to accurately estimate the size of its effect.

The Calpastatin marker (UoGCAST1) and the Calpain haplotypes based on CAPN4751 and CAPN316) were each highly significant. The combination of all three even more so. Each calpastatin "C" was associated with a decrease of 0.4 lb of Warner-Bratzler Shear Force, and substituting the Calpain 4751 "C" - 316 "C" haplotype for the Calpain 4751 "T" - 316 "G" was associated with a decrease of 0.7 lb of Warner-Bratzler Shear Force. Among genotypes with sufficient information there was a 2.3 lb. difference in WBSF between the best (homozygous C at all three markers) and the worst GG-TT-GG (UoGCAST1-CAPN4751-CAPN316). Breeders should not expect gains this large because no herd will consist 100% of the 'least tender' genotype.

Test Claims:

Igenity profile Tenderness is a DNA genetic marker panel test offered by Igenity. Increase in "tenderness" is associated with favorable alleles of a marker panel that includes Calpain 4751 (i.e. a "C" allele at the 4751 SNP of calpain), Calpain 316 (i.e. a "C" allele at the 316 SNP of calpain), and UofG-CAST1 (i.e. a "C" allele at the UofGCAST1).

Test Details:

Polymorphisms analyzed

- CAPN1 316 = SNP "316" in μ -calpain (micromolar calcium activated neutral protease 1).
- CAPN1 4751 = SNP "4751" in μ -calpain (micromolar calcium activated neutral protease 1).
- UofG-CAST1 = SNP in calpastatin (calpain inhibitor). Note this is a different SNP from CAST-T1 (**GeneSTAR® Tenderness**).

Sample Populations:

Cattle Used for Validation

1. Brahman Sired ARS, Brooksville cattle (344 animals)
* Brahman sires, Brahman dams
2. Brangus Sired CMP* cattle (219 animals)
* Brangus sires, primarily Brangus and some Brangus cross dams
3. Charolais Sired CMP* cattle (435 animals)
* Charolais sires, Black Angus dams
4. Red Angus Sired CMP* cattle (307 animals)
* Red Angus sires, mostly Red Angus dams, some crossbred
5. Black Angus cattle (394 animals)
* Angus sires, Black Angus dams

* CMP = carcass merit project; influential sires in their breed in the 1990s were utilized ("legacy bulls")

Allele Frequencies*:

Reference Population		CALPAIN 4751			CALPAIN 316			UoG-CAST1		
		CC	CT	TT	CC	GC	GG	GG	GC	CC
Combined	Genotype No.	426	724	556	113	561	1042	175	604	896
	Genotype %	25	42	33	7	33	61	14	48	71
	Allele %	46%		54%	23%		77%	28%		9448%
	Total No.		1706			1716			1268	
Brangus	Genotype No.	64	111	44	5	67	145	10	65	128
	Genotype %	29	51	20	2	31	67	5	32	63
	Allele %	55%		45%	18%		82%	21%		79%
	Total No.		219			217			203	
Charolais x Angus	Genotype No.	82	234	119	19	163	253	20	137	255
	Genotype %	19	54	27	4	37	58	5	33	62
	Allele %	46%		54%	23%		77%	26%		74%
	Total No.		307			307			305	
Red Angus	Genotype No.	63	165	79	15	110	182	23	111	171
	Genotype %	21	54	26	5	36	59	8	36	56

	Allele %	47%		53%	23%		77%	26%		74%
	Total No.		307			307				
Brahman	Genotype No.	5	45	280		10	333	113	163	68
	Genotype %	2	14	85		3	97	33	47	20
	Allele %	8%		92%	1%		99%	57%		43%
	Total No.		330			343			344	
Black Angus	Genotype No.	212	169	34	74	211	129	9	128	274
	Genotype %	51	41	8	18	51	31	2	31	67
	Allele %	71%		29%	43%		57%	18%		82%
	Total No.		415			414			411	

* These are the frequencies in the data analyzed and are not necessarily reflective of any purebred population.

IGENITY profile Tenderness Results :

A.

Reference Population	Trait	Number Head	Contrast			
			Gene(s)	DF	F	p
Combined	Warner-Bratzler Shear Force (lb)	1209	ITG** (UofG-Cast1 & CAPN1)	4	10.6	1.9E-08
			UofG-Cast1*	1	14.1	1.8E-04
			CAPN1 (4751 & 316 haplotype)*	3	9.3	4.7E-06
Branqus		181	ITG** (UofG-Cast1 & CAPN1)	4	1.7	0.16
			UofG-Cast1*	1	0.04	0.84
			CAPN1 (4751 & 316 haplotype)*	3	2.2	0.09
Charolais x Angus		400	ITG** (UofG-Cast1 & CAPN1)	4	8.0	3.1E-06
			UofG-Cast1*	1	8.2	4.4E-03
			CAPN1 (4751 & 316 haplotype)*	3	8.2	2.8E-05
Red Angus		310	ITG** (UofG-Cast1 & CAPN1)	4	2.9	0.02
			UofG-Cast1*	1	1.2	0.27
			CAPN1 (4751 & 316 haplotype)*	3	3.1	0.03
Brahman	318	ITG** (UofG-Cast1 & CAPN1)	3	4.3	0.01	
		UofG-Cast1*	1	5.8	0.02	
		CAPN1 (4751 & 316 haplotype)*	2	3.7	0.03	

Angus***	Warner-Bratzler Shear Force (lb)	318	ITG** (UofG-Cast1 & CAPN1)	4	8.2	0.00
			UofG-Cast1*	1	4.4	0.04
			CAPN1 (4751 & 316 haplotype)*	3	9.7	0.00

*** The Angus CMP population was analyzed at a later date than the other sample populations and so this data is not included in the combined analysis.

** ITG = Igenity profile Tenderness combined marker panel = total number of favorable UofG-Cast1 alleles & CAPN1 haplotypes.

*effect of UofG-Cast1 and CAPN1 haplotype estimated separately; CAPN1 haplotype has a larger effect than UofG-Cast1.

* Genotype effects constructed from effects estimated in the haplotype analysis (Table B)

B. Combined Three-marker Genotype Effects (contrasted to UoG-Cast1 "GG", Capn316 "GG", Capn4751 "TT"), Standard Errors and Frequencies* in Reference Samples

Genotype			Estimate (lbs.)	Standard Error	Number Obs.	%
UoG-Cast1	Calpain 316	Calpain 4751				
CC	CC	CC	-2.3	0.4	18	1.5
		CT	-1.1	0.6	8	0.7
		TT	0.1	1.0	0	0.0
	CG	CC	-1.9	0.3	60	5.0
		CT	-1.5	0.3	123	10.2
		TT	-0.4	0.5	9	0.7
	GG	CC	-1.6	0.3	60	2.7
		CT	-1.2	0.3	181	15.0

		TT	-0.8	0.2	212	17.5
CG	CC	CC	-1.9	0.3	9	0.7
		CT	-0.7	0.5	1	0.1
		TT	0.5	1.0	0	0.0
	CG	CC	-1.5	0.2	42	3.5
		CT	-1.1	0.2	74	6.1
		TT	0.1	0.5	4	0.3
	GG	CC	-1.2	0.3	23	1.9
		CT	-0.8	0.2	91	7.5
		TT	-0.4	0.1	204	16.9
GG	CC	CC	-1.4	0.3	2	0.2
		CT	-0.2	0.5	1	0.1
		TT	1.0	1.0	0	0.0
	CG	CC	-1.1	0.2	7	0.6
		CT	-0.7	0.1	9	0.7
		TT	0.5	0.5	0	0.0
	GG	CC	-0.8	0.3	5	0.4
		CT	-0.4	0.1	30	2.5
		TT	0		63	5.2

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C. Effect of One Copy of a UoGCAST1 Allele or CAPN1 Haplotype on the Target Trait

Population	Trait	No. Head	Gene	Allele/ Haplotype	Sample Frequency	Estimated Effect	Standard Error	
Combined	Warner- Bratzler Shear Force (Tenderness)	1209	UoGCAST	C	0.72	-0.42	0.11	
				G	0.28	0	-	
			CAPN1	C-C	0.16	-0.72	0.15	
				316 & 4751	C-T	0.01	0.48	0.50
				G-C	0.22	-0.40	0.13	
Bragus	Warner- Bratzler Shear Force (Tenderness)	181	UoGCAST	C	0.79	-0.05	0.26	
				G	0.21	0.00	-	
			CAPN1	C-C	0.17	-0.72	0.28	
				316 & 4751	C-T	0.00	-0.23	1.78
				G-C	0.37	-0.12	0.23	
Charolais x Angus	Warner- Bratzler Shear Force (Tenderness)	400	UoGCAST	C	0.79	-0.40	0.14	
				G	0.21	0	-	
			CAPN1	C-C	0.20	-0.76	0.16	
				316 & 4751	C-T	0.03	0.55	0.41
				G-C	0.26	-0.37	0.16	
Red Angus	Warner- Bratzler Shear Force (Tenderness)	310	UoGCAST	C	0.74	-0.19	0.17	
				G	0.26	0	-	
			CAPN1	C-C	0.23	-0.55	0.19	
				316 & 4751	C-T	0.01	0.86	0.85
				G-C	0.25	-0.24	0.20	
Brahman	Warner- Bratzler Shear Force (Tenderness)	318	UoGCAST	C	0.43	-0.73	0.30	
				G	0.57	0	-	
			CAPN1	C-C	0.02	-1.27	1.19	
				316 & 4751	C-T	0	-	-
				G-C	0.07	-1.36	0.56	
Angus***	Warner- Bratzler Shear Force (Tenderness)	394	UoGCAST	C	0.82	-0.30	0.14	
				G	0.18	0	-	
			CAPN1	C-C	0.43	-0.56	0.13	
				316 & 4751	C-T	0	-	-
				G-C	0.28	0.03	0.56	
			UoGCAST	C	0.28	0	-	
				G	0.72	0	-	
			CAPN1	C-C	0.16	-0.72	0.15	
				316 & 4751	C-T	0.01	0.48	0.50
				G-C	0.22	-0.40	0.13	

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