



# final report

Project code: L.EQT.1720 and L.EQT.1809

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L.EQT.1720. Using Consumer Sensory Testing to further enhance MSA beef model expansion and accuracy

L.EQT.1809 Consumer sensory evaluation of stored product

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## Executive summary

This report relates to the extensive consumer testing of sensory samples prepared from a number of previous MSA research collections, in particular, three Beef Information Nucleus (BIN) groups from which the collection is reported in L.EQT.1620.

Both contracts L.EQT.1720 and L.EQT.1809 relate to the sensory testing of these samples and for convenience are reported jointly as the product was intermixed for testing to better relate the source groups for statistical evaluation.

The projects were initiated to allow for further expansion and increased accuracy of the Meat Standards Australia (MSA) prediction model adding both new cut x cook combinations, further ageing data and extending the depth of data for combinations, which had not been tested for a considerable period and or had very low data volume in the AUSBlue database.

The projects have jointly met all objectives with the resulting data central to considerable expansion of the MSA prediction model with the new V2.0 version encompassing more than double (311) cut by cook combinations relative to the SP2009 version (169).

In addition to testing 26 additional muscle combination were cooked using new cook methods; Combi Oven moist heat roasting (COM) and Sous-Vide (SVD) cooking of diced product. In addition bone in cooking forms of ribs and osso bucco have been compared to boneless equivalents and data expanded considerably for slow cook/casserole (SC2), stir fry (SFR) and Yakiniku (YAK). Oyster blade have also been evaluated grilled in conventional and “flatiron” form.

The data, generated by 185 picks each utilising 60 consumers (11,100 consumers and 7,770 samples in total), has been processed to combine all available animal and processing history together with MSA grading data. The data was then forwarded to Dr Ray Watson and Dr Garth Tarr for statistical analysis related to both the individual trial outcomes and for inclusion in the data set utilised to develop the MSA V2.0 model.

The ensuing analysis has been progressively peer reviewed by the MSA Beef Pathways Committee over 18 months and a final model version approved for release.

The projects have dramatically expanded MSA prediction capability and represent a substantial step toward enabling the prediction of consumer satisfaction for any beef carcass portion cooked by alternative methods.

This basis is expected to add value to MSA based industry branding programs and increase revenue across the supply chain.

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# 1 Background

The Meat Standards Australia (MSA) prediction model is developed entirely from combining untrained consumer sensory response data with detailed information relating to the samples tested. The sensory data is utilised in two principal applications: to evaluate consumer sensory perception – what is the relative importance of tenderness, flavour, juiciness and overall satisfaction – and then utilising the resultant weighted combined Meat Quality (MQ4) score to identify information that may be useful for prediction of consumer response. All available background data on all samples including animal, carcass, muscle, ageing and cooking data are evaluated as to their direct relationship to the observed MQ4 and also their interaction.

The potential interactions demand more data across structured or at least diverse data sources to ensure a robust model. Questions answered include: is an effect common across all muscles or different, does it differ with animal breed, sex, age or feed type, does it interact with post mortem ageing, with cooking and many other factors. These issues are complex and require extensive data to identify and confirm relationships.

The Breed Information Nucleus (BIN) cattle provide an ideal source of data as the cattle are of known breed and are raised under known and detailed conditions and processed on common kill days. The current projects heavily utilised Northern, Hereford cross and Angus BIN kills, detailed in L.EQT.1620, to obtain samples from a diverse range of cattle and source locations. Virtually all muscles of sufficient size for consumer testing were collected from each carcass and then prepared for alternative cooking style and ageing combinations. For larger muscles this enabled “within animal” comparison of two to four combinations and for small muscles comparison across animals.

The MSA model has been expanded since the original 2000 release, as more data became available and additional factors investigated. Industry utilisation of MSA has also expanded dramatically both in number of cattle graded, from 300,000 per year to over 3 million, and in the cuts marketed under eating quality based brands. Whereas only a few “sweet” cuts were traditionally marketed as MSA, this has expanded to many more. A demand for an MSA output relating to muscles and cooking method combinations, which have not been currently available in current models, is also being positively viewed by industry.

Further, while some initial work had been conducted on slow cook and stir fry methods, relatively low numbers had been evaluated potentially more than 15 years earlier. Similarly yakiniku cooking had been incorporated in an initial Japanese study but not tested recently.

A driving factor has also been the Industry need to relate Handbook of Australian Meat (HAM – Anon 2005) numbers to MSA grade description. The convention is that where a cut has multiple muscles the lowest MSA MQ4 score for the component muscles is applied to the cut, whereas the actual MQ4 based grade can be applied to each muscle if separated for packing. New interest in marketing MSA based branded product to international markets has been complicated where some cuts, particularly from the forequarter, have muscle groupings not adequately tested or for which key cooking methods have inadequate or no data. This compromises brand marketing where a basic premise is that all product is MSA graded to provide an eating quality guarantee.

The projects, and related cut collection, were initiated to address these issues and enable both model expansion and increased prediction accuracy. Substantial industry benefit is anticipated through the ability to better describe, segregate and guarantee a wider range of Australian product delivering superior consumer value and commensurate industry revenue.

## 2 Project objectives

This Final Report relates to extensive product collected within three BIN projects with the Final Report L.EQT.1620 fully describing the collection and consumer product sample preparation. These samples, and some further yakiniku and stir fry samples from previous collections, have been consumer tested with the results central to development of the V2.0 MSA prediction model. As the samples were blended across many consumer sessions (picks – each being 60 consumers) this report addresses L.EQT.1720 and L.EQT.1809 for clarity and to avoid repetition.

The research contract for L.EQT.1720 lists the objectives as:

“The contracted project leader will facilitate data collation and analysis, report writing and objective flavour results associated with product collected.

Results will aim to:

- Improve model accuracy on cuts with limited information
- Expand the MSA model with new cut x cook combinations within the existing cook methods
- Create new cut x cook combinations with novel cook methods

Test existing cook methods, which may not have been tested recently, to see whether consumer sensory preferences have changed. “

Very similar objectives are listed in L.EQT.1809.

“This project will conduct consumer sensory testing on stir fry and yakiniku samples currently in storage at the University of New England. This sensory evaluation aims to contribute to the accuracy of prediction of these cook methods in the MSA Model. Some muscles in storage will add rigor to existing cut x cook combinations in the model, whereas others will be new combinations not previously available”.

## 3 Methodology

### 3.1 Cut collection

The cut collection methodology aligned with MSA protocols described in detail by Gee et.al (2006) and summarised in Anon (2008). Detail of the actual cuts collected within the BIN projects is extensively described within the L.EQT.1620 Final Report from which *Table 1* is sourced.

The *Table 1* cook description counts are grouped so that sous vide (SVD), osso bucco (OSO) and slow cook (SC2) are all within the SC2 category whilst Combi oven (COM) and dry roasting (RST) are all within RST in bone in and boneless forms. A flatiron form of GRL for oyster blade is also within GRL. There were 783 SVD and 100 OSO comparisons to SC2, 656 COM comparisons to RST and 34 flatiron comparisons to GRL.

Further detail of ageing comparisons by muscle are shown in *Table 2* and of cooking methods in *Table 3* with both tables sourced from the L.EQT.1620 Final report.

Table 1. Consumer samples fabricated by muscles and primary cook method from 3 BIN collections.

			NORTHERN BIN						HEREFORD BIN						ANGUS BIN						ALL BIN GROUPS						NEW
MUSCLE	CODE	Bone	GRL	RST	SC2	SFR	YAK	TOTAL	GRL	RST	SC2	SFR	YAK	TOTAL	GRL	RST	SC2	SFR	YAK	TOTAL	GRL	RST	SC2	SFR	YAK	TOTAL	
M.deltoideus	BLD011														16		16			32	0	0	16	0	16	32	Y
M.latissimus dorsi	BLD041														36					36	0	0	36	0	0	36	
M.subscapularis	BLD084				9	18	9	36			12	12	12	36			12	11	11	34	0	0	33	41	32	106	Y
M.teres major	BLD088		34					34	18						16					16	68	0	0	0	0	68	
M.triceps brachii caput laterale	BLD095					36		36				36		36			12	12	12	36	0	0	12	84	12	108	
M.triceps brachii caput longum	BLD096		6	12	30	12	12	72	6	24	24	6	12	72	12	24	13	11	12	72	24	60	67	29	36	216	
M.triceps brachii caput mediale	BLD097				18	9	9	36			24	6	6	36			12	12	12	36	0	0	54	27	27	108	Y
M.pectoralis profundus	BRI056			36	72			108		34	80	7	14	135		36	90	9	9	144	0	106	242	16	23	387	
M.pectoralis superficialis	BRI057				36	17	17	70			58	16	14	88			36	18	18	72	0	0	130	51	49	230	
M.brachiocephalicus	CHK007																27			27	0	0	27	0	0	27	Y
M.intercostales externus and internus	CHK037									1				1							0	1	0	0	0	1	Y
M.latissimus dorsi	CHK041			1	1			2													0	1	1	0	0	2	Y
M.longus colli	CHK047				3			3			6			6			36			36	0	0	45	0	0	45	Y
M.multifidi cervicis	CHK048				25			25			26			26			36			36	0	0	87	0	0	87	Y
M.pectoralis profundus	CHK056																		9	9	0	0	0	9	9	Y	
M.rhomboideus	CHK068				72			72			53			53			65			65	0	0	190	0	0	190	
M.semispinalis capitis	CHK074		7	7	14		7	35	6	3	21	3	3	36	12	18	34			64	25	28	69	3	10	135	
M.serratus ventralis cervicis	CHK078		9	26	36		18	89	29	24	37		18	108	9	17	45	18	27	116	47	67	118	18	63	313	
M.spinalis dorsi	CHK081		9		9	9	9	36	9		9	9	9	36	9		9	9	9	36	27	0	27	27	27	108	
M.splenius	CHK082				18	18		36			18	17		35			18	18		36	0	0	54	53	0	107	
M.trapezius cervicalis	CHK093																36			36	0	0	36	0	0	36	Y
M.intercostales externus and internus	CHK137	Y		18				18		18				18		18				18	0	54	0	0	0	54	Y
M.pectoralis profundus	CHK156	Y		9				9		9				9		9				9	0	27	0	0	0	27	Y
M.serratus ventralis cervicis	CHK178	Y		9				9		9				9		9				9	0	27	0	0	0	27	Y
M.pectoralis profundus	CHK256			9				9		9				9		9				9	0	27	0	0	0	27	Y
M.serratus ventralis cervicis	CHK278			9				9		9				9		9				9	0	27	0	0	0	27	Y
M.intercostales externus and internus	CHK337			16				16		18				18		18				18	0	52	0	0	0	52	Y
M.supraspinatus	CTR085		3	15	54			72	3	15	52			70	12	24	35			71	18	54	141	0	0	213	
M.semitendinosus	EYE075			18	35	9	9	71		18	36	9	9	72		12	34	12	12	70	0	48	105	30	30	213	
M.biceps brachii	FQS004				18			18			18			18			36			36	0	0	72	0	0	72	Y
M.brachialis	FQS006				17			17			17			17			36			36	0	0	70	0	0	70	Y
Flexor/extensor muscle group surrounding the radius	FQSHIN	y			36			36			71			71			55			55	0	0	162	0	0	162	
M.peroneus tertius	HQS059				18			18			18			18			28			28	0	0	64	0	0	64	Y
Muscle group surrounding the tibia	HQSHIN	y			36			36			64			64			56			56	0	0	156	0	0	156	
M.intercostales externus and internus	INT037			31		14		45		25	5	1		31		35	18	18		71	0	91	23	33	0	147	
M.intercostales externus and internus	INT237			36				36		36				36		36				36	0	108	0	0	0	108	Y
M.rectus femoris	KNU066			18	18			36		18	18			36		18	18			36	0	54	54	0	0	108	
M.vastus intermedius	KNU098				8	9		17			9	9		18			9	9		18	0	0	26	27	0	53	

M.vastus lateralis	KNU099		18	35		9	<b>62</b>			18	35		4	<b>57</b>			18	36		9	<b>63</b>		0	54	106	0	22	<b>182</b>			
M.vastus medialis	KNU100					9	<b>9</b>	<b>18</b>					9	<b>9</b>	<b>18</b>					9	<b>9</b>	<b>18</b>		0	0	0	27	27	<b>54</b>		
M.biceps femoris (syn. gluteobiceps)	OUT005		9	18	36		9	<b>72</b>		11	18	36		9	<b>74</b>		7	18	36		9	<b>70</b>		27	54	108	0	27	<b>216</b>	Y	
M.flexor digitorum sublimis	OUT027																		12			<b>12</b>		0	0	12	0	0	<b>12</b>		
M.gastrocnemius	OUT029		18	18				<b>36</b>		18	18				<b>36</b>		17	18				<b>35</b>		0	53	54	0	0	<b>107</b>		
M.infraspinatus	OYS036		23	23	20	13	11	<b>90</b>		27	27	12	15	9	<b>90</b>		24	24	18	12	12	<b>90</b>		74	74	50	40	32	<b>270</b>		
M.latissimus dorsi	RIB041											9		9	<b>18</b>				18	9	9	<b>36</b>		0	0	27	9	18	<b>54</b>	Y	
M.serratus ventralis thoracis	RIB078				4	9	7	<b>20</b>												9	9	<b>18</b>		0	0	4	18	16	<b>38</b>		
M.intercostales externus and internus	RIB137	y	18					<b>18</b>		18					<b>18</b>		18					<b>18</b>		0	54	0	0	0	<b>54</b>		
M.latissimus dorsi	RIB141	y	18					<b>18</b>		18					<b>18</b>		18					<b>18</b>		0	54	0	0	0	<b>54</b>	Y	
M.latissimus dorsi	RIB241		18					<b>18</b>		18					<b>18</b>		18					<b>18</b>		0	54	0	0	0	<b>54</b>	Y	
M.intercostales externus and internus	RIB337		20					<b>20</b>		18					<b>18</b>		18					<b>18</b>		0	56	0	0	0	<b>56</b>	Y	
M.biceps femoris (syn. gluteobiceps)	RMP005		9	9		9	9	<b>36</b>		5	6		12	11	<b>34</b>		8	7		9	8	<b>32</b>		22	22	0	30	28	<b>102</b>	Y	
M.gluteus accessorius	RMP030												11	1	<b>12</b>					7		<b>7</b>		0	0	0	18	1	<b>19</b>		
M.gluteus profundus	RMP032					9	9	<b>18</b>				3			<b>3</b>									0	0	3	9	9	<b>21</b>		
M.tensor fasciae latae	RMP087			6		6	6	<b>18</b>									4	5		7	2	<b>18</b>		4	11	0	13	8	<b>36</b>		
M.gluteus medius	RMP131		9	18		9	9	<b>45</b>		10	16		8	9	<b>43</b>		9	18		9	9	<b>45</b>		28	52	0	26	27	<b>133</b>		
M.gluteus medius	RMP231		9	18		9	9	<b>45</b>		3	15		9	9	<b>36</b>		4	18		7	7	<b>36</b>		16	51	0	25	25	<b>117</b>		
M.longissimus dorsi	STR045		67	36	72			<b>175</b>		72	36	72			<b>180</b>		36	67	36	18	18	<b>175</b>		175	139	180	18	18	<b>530</b>	Y	
M.multifidi cervicis	STR049																		17			<b>17</b>		0	0	17	0	0	<b>17</b>		
M.iliacus	TDR034		18					<b>18</b>		18					<b>18</b>		18					<b>18</b>		54	0	0	0	0	<b>54</b>		
M.psoas major	TDR062		12	36		12	12	<b>72</b>		3	36		7	12	<b>58</b>		9	34		9	8	<b>60</b>		24	106	0	28	32	<b>190</b>		
M.obliquus externus abdominis	TFL051				12	12	12	<b>36</b>				12	12	12	<b>36</b>				12	12	12	<b>36</b>		0	0	36	36	36	<b>108</b>	Y	
M.obliquus internus abdominis	TFL052				12	12	12	<b>36</b>				12	12	12	<b>36</b>				12	12	12	<b>36</b>		0	0	36	36	36	<b>108</b>		
M.rectus abdominis	TFL064				12	12	12	<b>36</b>				12	11	12	<b>35</b>				12	12	12	<b>36</b>		0	0	36	35	36	<b>107</b>		
M.adductor femoris	TOP001				12	12	12	<b>36</b>				12	11	11	<b>34</b>				12	12	12	<b>36</b>		0	0	36	35	35	<b>106</b>	Y	
M.gracilis	TOP033					36		<b>36</b>											36			<b>36</b>		0	0	72	0	0	<b>72</b>		
M.pectineus	TOP055					9	9	<b>18</b>												9	9	<b>18</b>		0	0	0	18	18	<b>36</b>		
M.semimembranosus	TOP073		18	36	72		18	<b>144</b>		17	34	67		17	<b>135</b>		18	36	72		18	<b>144</b>		53	106	211	0	53	<b>423</b>		
TOTAL			242	580	924	293	264	2303		237	566	976	248	243	2270		207	626	1205	319	331	2688		686	1772	3105	860	838	7261	26	

**Table 2. Ageing comparisons by muscle prepared from BIN cut collections**

Days Aged	NORTHERN BIN						HEREFORD BIN				ANGUS BIN		
	7	8	10	11	28	TOTAL	7	8	28	TOTAL	4	28	TOTAL
BLD011											18	14	32
BLD041											18	18	36
BLD084		36				36	27		9	36	18	16	34
BLD088		34				34	18			18	16		16
BLD095		36				36	18		18	36	18	18	36
BLD096		59			13	72	48		24	72	36	36	72
BLD097		36				36	18		18	36	18	18	36
BRI056		72			36	108	83		52	135	81	63	144
BRI057		52			18	70	56		32	88	37	35	72
CHK007											16	11	27
CHK037							1			1			
CHK041				2		2							
CHK047		3				3	2		4	6	18	18	36
CHK048				24	1	25	12		14	26	18	18	36
CHK056											9		9
CHK068		36			36	72	26		27	53	32	33	65
CHK074		35				35	26		10	36	32	32	64
CHK078		89				89	72		36	108	63	53	116
CHK081		36				36	24		12	36	18	18	36
CHK082		36				36	23		12	35	18	18	36
CHK093											18	18	36
CHK137		18				18	18			18	18		18
CHK156		9				9	9			9	9		9
CHK178		9				9	9			9	9		9
CHK256		9				9	9			9	9		9
CHK278		9				9	9			9	9		9
CHK337		16				16	18			18	18		18
CTR085		43		2	27	72	43		27	70	36	35	71
EYE075			54		17	71	54		18	72	37	33	70
FQS004			18			18	9		9	18	18	18	36
FQS006			17			17	8		9	17	18	18	36
FQSHIN	36					36	71			71	55		55
HQS059	18					18	9		9	18	12	16	28
HQSHIN	36					36	46		18	64	56		56
INT037		45				45	31			31	71		71
INT237		36				36	36			36	36		36
KNU066			36			36	36			36	20	16	36
KNU098			17			17	18			18	12	6	18
KNU099			57		5	62	39		18	57	36	27	63
KNU100			18			18	18			18	12	6	18
OUT005			54		18	72	50		22	72	42	30	72
OUT027											5	7	12
OUT029			36			36	36			36	23	12	35
OYS036		90				90	90			90	44	46	90
RIB041							18			18	24	12	36
RIB078		20				20					12	6	18
RIB137		18				18	18			18	18		18
RIB141		18				18	18			18	18		18
RIB241		18				18	18			18	18		18
RIB337		20				20	18			18	18		18
RMP005			36			36		34		34	16	16	32
RMP030								12		12	2	5	7
RMP032			18			18		3		3			
RMP087			18			18					11	7	18
RMP131			45			45		43		43	22	23	45
RMP231			45			45		36		36	17	19	36
STR045	121				54	175	108		72	180	103	72	175
STR049											8	9	17
TDR034			18			18	18			18	9	9	18
TDR062			72			72	58			58	32	28	60
TFL051		36				36	24		12	36	18	18	36
TFL052		36				36	24		12	36	18	18	36
TFL064		36				36	23		12	35	18	18	36
TOP001			36			36	34			34	18	18	36
TOP033			36			36					18	18	36
TOP055			18			18					12	6	18
TOP073			108		36	144	93		42	135	73	71	144
<b>TOTAL</b>	<b>211</b>	<b>1046</b>	<b>757</b>	<b>28</b>	<b>261</b>	<b>2303</b>	<b>1592</b>	<b>128</b>	<b>548</b>	<b>2268</b>	<b>1610</b>	<b>1080</b>	<b>2690</b>



**Table 3. Cooking methods utilised within muscle and source primal cut from 3 BIN cut collections**

Cut & HAM Collected	Cut Derivatives & HAM	MSA Code	HAM	H.A.M. Muscle Name	COOK CODES PREPARED
CHUCK 2260		CHK007	7	M. brachiocephalicus	SC2
		CHK041	41	M. latissimus dorsi	COM, SC2
	Neck chain 2460	CHK047	47	M. longus colli	SC2
		CHK048	48	M. multifidus cervicis	SC2
		CHK056	56	M. pectoralis profundus	YAK
	Chuck crest 2278	CHK068	68	M. rhomboideus	SC2, SVD
		CHK074	74	M. semispinalis capitis	GRL, RST, SC2, SFR, SVD, YAK
		CHK078	78	M. serratus ventralis cervicis	COM, GRL, RST, SC2, SFR, SVD, YAK
		CHK081	81	M. spinellus dorsi	GRL, SC2, SFR, YAK
		CHK082	82	M. splenius	SC2, SFR
		CHK093	93	M. trapezius cervicalis	SC2
	Spare ribs 1695	CHK137	37	M. intercostales externus and internus	COM, RST
	Chuck short ribs 1631	CHK156	56	M. pectoralis profundus	COM, RST
	Chuck short ribs 1631/Chuck rib meat 1696	CHK178	78	M. serratus ventralis cervicis	COM, RST
		INT237	37	M. intercostales externus and internus	COM, RST
	Chuck rib meat 2640/chuck meat square 2645	CHK256	56	M. pectoralis profundus	COM, RST
	Chuck rib meat 2640/chuck meat square 2645	CHK278	78	M. serratus ventralis cervicis	COM, RST
		CHK337	37	M. intercostales externus and internus	COM, RST
CHUCK TENDER 2310	Chuck Tender 2310	CTR085	85	M. suboccipitalis	COM, GRL, RST, SC2, SVD
BLADE 2300		BLD011	11	M. deltoideus	SC2, YAK
		BLD041	41	M. latissimus dorsi	SC2
	Blade Undercut 2304	BLD084	84	M. subscapularis	SC2, SFR, YAK
		BLD088	88	M. teres major	GRL
	Bolar Blade 2302	BLD095	95	M. biceps brachii caput laterale	SC2, SFR, YAK
	Bolar Blade 2302	BLD096	96	M. biceps brachii caput longum	COM, GRL, RST, SC2, SFR, SVD, YAK
	Bolar Blade 2302	BLD097	97	M. biceps brachii caput mediale	SC2, SFR, SVD, YAK
OYSTER BLADE 2304	Oyster Blade 2304	OYS036	36	M. trisplanatus	COM, FLT, GRL, RST, SC2, SFR, SVD, YAK
RIBSET 2223	Intercostals 2430	INT037	37	M. intercostales externus and internus	COM, RST, SC2, SFR
	Rib cap 2470	RIB041	41	M. latissimus dorsi	SC2, SFR, SVD, YAK
	Short rib meat 2465	RIB078	78	M. serratus ventralis thoracis	SC2, SFR, YAK
	Spare ribs 1695	RIB137	37	M. intercostales externus and internus	COM, RST
	Short ribs 1694	RIB141	41	M. latissimus dorsi	COM, RST
		INT237	37	M. intercostales externus and internus	COM, RST
	Rib meat square 2650	RIB241	41	M. latissimus dorsi	COM, RST
		RIB337	37	M. intercostales externus and internus	COM, RST
BRISKET 2323		BRK056	56	M. pectoralis profundus	COM, RST, SC2, SFR, SVD, YAK
		BRK057	57	M. pectoralis superficialis	SC2, SFR, SVD, YAK
FQ Shin 1682	Shin/shank forequarter 1682/2360/2365/Group F	FQS011	11	Flexor/extensor muscle group surrounding	SC2, OSO
	Arm bone shin 1685/ Shin special trim C conical muscle	FQS004	4	M. biceps brachii	SC2, SVD,
	Arm bone shin 1685/ Shin special trim E	FQS006	6	M. brachialis	SC2, SVD,
TENDERLOIN 2150	Butt Tenderloin 2170	TDR034	34	M. ileus	GRL
	Tenderloin 2150	TDR062	62	M. psoas major	COM, GRL, RST, SFR, YAK
STRIPLOIN 2140		STR045	45	M. longissimus dorsi	COM, GRL, RST, SC2, SFR, SVD, YAK
		STR048	48	M. multifidus cervicis	SC2
RUMP 2090	Rump Cap 2091	RMP005	5	M. biceps femoris (syn. gluteobiceps)	GRL, RST, SFR, YAK
		RMP030	30	M. gluteus accessorius	SFR, YAK
		RMP032	32	M. gluteus profundus	SC2, SFR, YAK
	Tri-Tip 2131	RMP087	87	M. tensor fasciae latae	GRL, RST, SFR, YAK
	Rostbiff 2110/D-Rump 2100 (sets grade for both)	RMP131	31	M. gluteus medius	COM, GRL, RST, SFR, YAK
	Rostbiff 2110	RMP231	31	M. gluteus medius	COM, GRL, RST, SFR, YAK
SILVERSIDE 2020	Outside Flat 2050/Outside meat 2033	OUT005	5	M. biceps femoris (syn. gluteobiceps)	COM, GRL, RST, SC2, SFR, SVD, YAK
	FDS	OUT027	27	M. flexor Digitorum Superficialis	SC2
	Heel Special Trim 2365 Group B	OUT029	29	M. gastrocnemius	COM, RST, SC2, SVD
EYE ROUND 2040	Eye Round 2040/Inside meat 2035	EYE075	75	M. semitendinosus	COM, RST, SC2, SFR, SVD, YAK
TOPSIDE 2000		TOP001	1	M. adductor femoris	SC2, SFR, YAK
	Topside Cap 2002	TOP033	33	M. gracilis	SC2, SVD
		TOP055	55	M. pectineus	SFR, YAK
	Cap off Topside 2001/Inside meat 2035	TOP073	73	M. semimembranosus	COM, GRL, RST, SC2, SVD, YAK
KNUCKLE 2070	M. rectus femoris 2067	KNU066	66	M. rectus femoris	COM, RST, SC2, SVD
	M. vastus intermedius 2069	KNU098	98	M. vastus intermedius	SC2, SFR
	M. vastus lateralis 2068	KNU099	99	M. vastus lateralis	COM, RST, SC2, SVD, YAK
		KNU100	100	M. vastus medialis	SFR, YAK
THIN FLANK 2200	External flank Plate 2204	TFL051	51	M. obliquus externus abdominis	SC2, SFR, YAK
	Internal Flank Plate 2203 & Flap Meat 2206	TFL052	52	M. obliquus internus abdominis	SC2, SFR, YAK
	Flank Steak 2210	TFL064	64	M. rectus abdominis	SC2, SFR, YAK
HQ Shank	Shin/shank hindquarter 1683/2360/2365 Group A/D	HQS011	11	Muscle group surrounding the tibia	OSO, SC2
	Shin/shank hindquarter 1683/2360/2365 Group A	HQS059	59	M. peroneus tertius	SC2, SVD

## 3.2 Cooking Protocol development

The new cooking methods and forms required suitable protocol development prior to consumer testing. Each was a modification to an existing form, with the serving process remaining identical to allow comparison of each variation within common consumer groups (picks).

### 3.2.1 Sous vide (SVD)

The sous vide protocol developed by Neveu et.al (2017) is attached within the appendix section 9.2. In brief, identical twenty two notionally 21 x 21 x 21mm or equivalent mass cubes are prepared for each sample whether SC2 or SVD. Whereas the SC2 protocol specifies browning of the cubes for 90 seconds, followed by a rolling boil in a light vegetable based broth for 2 hours, the SVD protocol does not brown the cubes. They instead remain in a vacuum pouch for cooking in 65°C circulating water for 3 hours.

Post cooking the SVD cubes are transferred to a bain marie pan with the same broth used for the SC2 cooking. Both methods then hold the cubes and broth in 1/9th bain marie steamer pans at 50°C until served. Each consumer is served 2 cubes from a sample and evaluates 7 samples in total.

SVD cooking times were evaluated from 2 to 12 hours prior to electing the 3 hour standard. The 65°C cooking temperature was adopted after discussion with Dr Robyn Warner of Melbourne University and reference to literature.

All comparisons were made by preparing two sample sets from the same carcass and muscle. Where a cut from a single carcass side was of sufficient size for two samples the paired second side was utilised for an additional ageing comparison. Additionally, where the cut was large, typically topside (*M.semimembranosus* muscle) and outside flat (*M.biceps femoris* muscle) up to four ageing x cook comparisons were obtained.

Further work to evaluate sous vide cooking of grill and roast forms is recommended.

### 3.2.2 Osso Bucco (OSO)

The only variation to the SC2 protocol for OSO was the preparation of the raw sample, with the fore or hindquarter shin sawn into approximately 21mm slices across the bone. Two to three bone in slices were utilised per sample with the shin from the other carcass side boned out and 22 standard SC2 cubes prepared.

The bone in OSO slices were browned for 90 seconds, as were the SC2 pairs, and then further cooked at a rolling boil for 2 hours in 600 ml of the standard broth. A larger 1/6<sup>th</sup> steamer pan was required to hold the OSO sample during cooking.

After cooking the bone was removed and 22 cubes were cut from the cooked material for serving.

### **3.2.3 Combi Oven (COM)**

The developed combi oven protocol developed by Neveu et.al (2017) is included in the appendix section 9.3. The development of a moist heat roasting alternative reflected the utilisation of MSA product within food service environments, where cooking equipment could differ from domestic appliances. The combi oven provides for steam in addition to dry heat settings.

The protocol development was conducted using a pair of Electrolux™ ovens, with one set to dry heat of 160°C following the MSA RST protocol and the other to combination mode at 80°C (the maximum when set on the combination mode) typical of food service settings.

The final protocol specified that roasts from both the dry and moist heat processes be removed when an internal temperature of 65°C was attained, rested for a minimum of 10 minutes then prepared for serving in accordance with the existing RST protocol.

### **3.2.4 Bone-in and Boneless Roast comparison**

Further protocol development was conducted in regards to suitable methods to compare bone-in and boneless cooking forms. In all cases the product was served to consumers in boneless form, the bone being removed after cooking and prior to serving for the bone-in material.

The bone in Chuck and Short rib portions include multiple muscles including intercostals and the larger covering *M.serratus ventralis* and, in some portions, *M.pectoralis profundus* and *M.latissimus dorsi* muscles where longer rib sets are prepared.

To avoid confounding possible bone in effects with a potential effect from cooking the muscles as a group, the boneless comparisons utilised the same muscles, which were netted tightly together for cooking.

The muscles were separated for serving after removing the netting or by deboning the cooked portions. In all trial comparisons, carcass side was rotated between treatments.

### **3.2.5 Flatiron Oyster Blade**

Under the standard MSA GRL protocol the oyster blade (*M.infraspinatus*) is prepared by cutting across the grain with the internal heavy connective tissue sheath retained during cooking but removed during serving.

The “flatiron” form, popularised in the USA, is prepared by removing the connective tissue sheath pre cooking and preparing two steak pieces. One piece is utilised from either side of the connective tissue as larger flat portions, with the grain running parallel to the steak surface.

This preparation was followed for the flatiron protocol and compared to the standard preparation, with the comparisons conducted between cuts from sides of common bodies.

## **3.3 Sensory Testing**

Sensory testing of all product was conducted in accordance with MSA protocols (Gee, A. 2006b) also summarised in Anon (2008). In brief 60 consumers, referred to as a “Pick”, test 42 beef samples per pick, each sample being served to 10 consumers. After a first mid quality “Link” sample, the order of serving of 6 test products is controlled by a 6x6 Latin square which ensures that each product is served equally before and after each other product and equally in each serving order position. There are 6 individual samples, with each of the six products representing anticipated extremes of eating quality to ensure range. Each consumer receives one sample from each product. Each sample, prepared from a specific muscle portion, is served in 5 portions which are halved after cooking to serve a total of 10 consumers. The 5 serving portions are presented in 5 different serving orders and within 5 subsets of 12 consumers to ensure distribution across serving orders and consumer groups.

The allocation procedures are common across all cooking methods, although sample preparation and seating varies with Roasts being served to 60 people in a single setting, grills to 3 sittings of 20 and Yakiniku to individual tables of 5.

### **3.3.1 Selection and Preparation of samples prior to cooking**

Samples are stored after initial fabrication then allocated to specific picks prior to sensory evaluation. Further processes related to cooking method may be required prior to final cooking and serving, with cooking also occurring either directly prior to serving or prior to storing. A brief summary follows;

### *Grill*

A process referred to as 'posting' is required after selection of samples for a grill pick. This process disperses the 5 steaks within each sample to ensure each is served in a different round (cooking order) and to 5 different designated consumer pairs.

This is managed by transferring the 5 steaks to specific positions on 5 of 21 A4 Round Sheets within a pick. A round is a cooking cycle of 10 steaks for one sitting, a group of 20 consumers. There are 7 rounds per session (ensuring that each consumer receives 7 samples) and 3 sittings of 20 consumers.

Each Round Sheet has 20 nominated Eating Quality Reference (EQSRef) dictating the position of each steak. The sheet is positioned beside the Silex grill and steaks are transferred to the grill in the same 3 – 4 – 3 left to right, top to bottom sequence to maintain ID and control the allocation to consumer. The posting process must be conducted prior to the sensory event and can be done much earlier as product remains frozen until thawing 24 hours prior to cooking and serving.

### *Roast*

Roasts and the related COM method require no preparation pre-cooking, with cooking commencing 3 hours prior to serving.

### *SC2, SVD and OSO*

No further preparation is required prior to cooking these slow cook forms however the cooking process precedes the consumer event, generally by 24 hours with the samples chilled after cooking. The cooked samples are reheated to 50°C in a bain marie prior to serving.

### *Stir fry*

The stir fry samples are prepared as a block of fixed dimension during initial cut fabrication. After picking for a consumer event each block must then be sliced into 10 x 10 x 75mm straws which are cooked prior to serving. Cooking is generally conducted the day prior to serving using two woks and timed procedures with samples chilled post cooking. The cooked material is reheated to 50°C in a bain marie prior to serving.

### *Yakiniku*

As with stir fry, the yakiniku samples are fabricated, frozen and stored as a block prior to selection for a consumer pick. The blocks must then be sliced to produce 4 x 20 x 75mm strips which are placed on Round Sheets that designate the 7 samples for each consumer in order of serving. The sliced strips are vacuum packed on the sheets to maintain position and held frozen. The sheets are thawed immediately prior to cooking and the slices cooked individually and served immediately with 5 consumers being seated for serving by a "host".

### 3.3.2 Pick Design

The projects involved 185 individual picks, each testing 42 samples served to 60 people. Each consumer evaluated 7 samples and each sample was evaluated by 10 consumers. *Table 4* summarises the number of picks conducted by cooking method and where applicable the mix of subsidiary cooking methods within picks. It can be seen that 100 OSO and 783 SVD samples were served in conjunction with standard SC2 preparation. By serving these within a common pick the statistical power is improved as all are evaluated by a common group of people at a common time and location.

**Table 4. Summary of consumer Picks conducted**

COOK	PICKS	Samples	Sub Cook	Samples	Consumers
GRL	26	1,092	Flatiron	34	1,560
RST & COM	40	1,680	COM	656	2,400
SC2	5	210			300
SC2 + OSO	5	210	OSO	100	300
SC2 + OSO + SVD	13	546			780
SC2 + SVD	50	2,100	SVD	783	3,000
SFR	23	966			1,380
YAK	23	966			1,380
	<b>185</b>	<b>7,770</b>			<b>11,100</b>

A summary of the cooking methods and source product within each pick is presented in the Appendix section 9.1.

### 3.3.3 Consumer Evaluation

Sensory evaluation followed standard MSA test protocols as summarised in Anon (2008). Consumers were recruited through organisations that were remunerated for providing the group. The consumer participation supported their group, a recruiting process that has been found to encourage attendance through loyalty to the group and also to deliver a mix of demographics. Consumers were screened to be over 18 years old, to prefer beef cooked medium and to eat beef at least once per fortnight.

Each consumer recorded basic demographic data when seated at the event with each session instructed on how to record their scores. Each consumer was then provided with crackers and sip of water mixed apple juice for between samples as a palate cleanser.

Seven scoring sheets were provided with each labelled with the sample EQSRef code in serving order. Consumers were requested to check this code against the delivered plate label. The scoring sheets contained four 100mm line scales and a choice of 4 category descriptions for each sample.

The line scales were headed tenderness, anchored with the words not tender and extremely tender, juiciness anchored by not juicy and extremely juicy, flavour, anchored by dislike extremely and like extremely and overall satisfaction anchored by like extremely and dislike extremely.

The four category choices, with one only to be marked per sample, carried the descriptions of Unsatisfactory, Good everyday quality, Better than everyday quality and Premium.

For each sample the consumer placed a mark across each line scale, recording their assessment, and marked one of the category choice boxes. Serving staff checked that each sheet was completed prior to the consumer turning to the next sheet.

After serving the 7<sup>th</sup> sample a Willingness to pay sheet was presented with price line scales carrying the same category descriptions and anchored with \$0 and \$80. Consumers were asked to record if they were the normal purchaser of beef and to mark each line scale in accordance with perceived value for each quality description.

A copy of the sensory recording sheets is attached as section 9.4 of the appendix.

### **3.3.4 Data Management**

The sensory data was double entered and compared to ensure accuracy with any difference greater than 1mm rechecked. The completed file was then emailed and checked by software routines to ensure that each consumer received the 7 samples as designated and in the required order. The software then calculated the MQ4 score for each consumer sample and grouped the 10 consumer results for each sample EQSRef code. The mean of the 10 scores for each trait was then calculated together with a clipped mean of the central 6 values after omitting (clipping) the two highest and two lowest recordings within each trait.

The completed sensory file was then stored and the raw mean and clipped values for each sample added to the animal, grading and process data in the AUSBlue database.

After further checking of data for completeness, files were then extracted from AUSBlue and forwarded to Dr Watson and Dr Tarr for statistical analysis.

## 4 Results

The primary result for these projects is the collection and transfer of valid data to Dr Watson and Dr Tarr for development of a new prediction model version V2.0. The need for metadata and the complexity of the statistical process has been greater than in recent versions due to the model basis being changed thus requiring estimates to be built from a zero base rather than adjustment to existing structures and values.

V2.0 replaces the previous tropical breed content % input, a major calculation component with a direct model calculation based on hump height relationships. This and a previously unknown interaction between hump height and HGP will significantly modify primary model interactions although in general expected outcomes should be similar for those cut x cook combinations supported by extensive prior data.

The new data provided by these projects adds to the existing resource but also extends the scope by doubling the available cut x cook combinations, now 311, and introducing new cooking alternatives. These additions add considerably to the calculation task but also bring closer the ability to predict a consumer outcome for all muscles, of suitable size, for the majority of potential cooking methods.

The scope of the prediction process is illustrated by the example in *Table 5*, which displays the MQ0 values for muscle x cook alternatives within each of the muscles contained in the traditional rump primal cut.

**Table 5. Draft MQ0 values for muscle x cook combinations within the rump primal cut**

Muscle x Cook	MQ0 (draft)		Muscle x Cook	MQ0 (draft)
RMP005.GRL	63.1		RMP131.GRL	52.7
RMP005.RST	65.2		RMP131.RSC	58.4
RMP005.SC2	67.8		RMP131.RST	58.4
RMP005.SFR	68.2		RMP131.SC2	58.5
RMP005.TSL	70.0		RMP131.SFR	57.2
RMP005.YAK	69.7		RMP131.SSB	48.9
			RMP131.TSL	59.8
RMP032.SC2	65.2		RMP131.YAK	56.5
RMP032.SFR	62.8			
RMP032.TSL	63.3		RMP231.GRL	55.1
			RMP231.RSC	55.7
RMP087.GRL	61.5		RMP231.RST	60.9
RMP087.RST	59.5		RMP231.SFR	61.4
RMP087.SC2	65.0		RMP231.TSL	61.7
RMP087.SFR	61.5		RMP231.YAK	64.1
RMP087.TSL	60.1			
RMP087.YAK	57.6			



The MQ0 value is a base MQ4 value that is further adjusted in relation to grading inputs. As shown, there is a huge range in values both between and within the individual muscles, in the example from 48.9 to 70 MQ4.

These values are further adjusted for interactions with hump height, HGP, sex, carcass weight, rib fat, marbling, ossification, pH and days aged illustrating the complexity of the prediction development and the heavy reliance on metadata drawn from diverse sources.

During the model development process each sub set of data was analysed and results compared for each muscle, cook, combination and within cattle types, hanging methods and ageing period etc. In general, these refined existing model predictions despite the basic change to prediction inputs without major shifts in MQ4 estimates, particularly where existing data was substantial.

In other cases however discrepancies were observed leading to requests for further data and discussion with the MSA Beef Pathways Committee, MSA and research personnel regarding potential influences. In particular some slow cook values were observed as lower than in the previous versions raising concerns despite the previously sparse or older data. Additional SC2 data to augment that available was obtained from independent Polish, New Zealand and USA research work and each contributing trial independently analysed and compared.

One individual BIN dataset had unexplained lower SC2 values and after consideration of other data was down weighted in the final estimates with requests noted to gather further comparative data in future. This and other identified areas of uncertainty were noted and have been programmed for further evaluation through additional testing.

## 5 Discussion

The projects illustrate the value and need for extensive metadata derived from diverse sources. The value of leverage through pooling of global data is also evident with benefits in data spread and the cost saving in non-duplicated collection substantial.

The objective to be able to MSA grade all Australian cattle by 2020 has been advanced by the projects with an important allied goal of being able to accurately predict consumer response for all muscles of consequence cooked by an extensive range of cooking methods. Further allied research work relating to long slow smoking of briskets and ribs will add to the cooking options and planned new work relating to currently exempted cattle pathways will advance the 2020 ambition.

The new V2.0 model framework is regarded as a substantial step forward and able to accommodate further findings over time given far greater flexibility in independent muscle x input calculation. It also provides a more structured base that may be more readily adopted by other researchers and statistical modellers.

## 6 Conclusions/recommendations

The project has added substantial data and additional knowledge to the existing MSA beef model. The data has enabled a doubling of possible cut by cook outcomes and more robust prediction.

Further evaluation of sous vide grill and roast forms is recommended as is a review of potential additional food service cooking alternatives.

It is recommended that further data be collected to enable the 2020 grading of all cattle with the primary target alternative of non-eligible pathways. It is recommended that these collections also encompass further evaluation of issues identified by the statistical process as requiring additional data to ensure robust prediction across all criteria.

It is further recommended that efforts be continued to encourage and facilitate the pooling of international data to provide the broadest pool of genotype, phenotype and management systems and empower efficient further prediction accuracy.

## 7 Key messages

The projects have added considerable data resulting from the testing of 7,770 samples by 11,100 consumers.

The projects have tested a further 26 muscles not included in previous models enabling estimation of virtually all HAM codes.

New cooking methods including sous vide of casserole beef, combi oven high moisture roasting, flatiron preparation of oyster blade and bone in versus boneless cooking forms for rib and shin cuts have been tested.

These data have enabled a doubling of the muscle x cook combinations predicted within the new MSA V 2.0 model.

## 8 Bibliography

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## 9 Appendix

### 9.1 List of consumer picks, cooking method and product mix within pick

PICK	COOK	PRODUCT SOURCE	PICK	COOK	PRODUCT SOURCE
1267	GRL	BIN cut by cook	1312	RST + COM	BIN cut by cook
1268	GRL	BIN cut by cook	1313	RST + COM	BIN cut by cook including bone in
1269	GRL	BIN cut by cook	1314	RST + COM	BIN cut by cook including bone in
1270	GRL	BIN cut by cook	1315	SC2 + SVD	BIN cut by cook
1271	GRL	BIN cut by cook	1316	SC2 + SVD	BIN cut by cook
1272	GRL	BIN cut by cook	1317	SC2 + SVD	BIN cut by cook
1273	GRL	BIN cut by cook	1318	SC2 + SVD	BIN cut by cook
1274	GRL	BIN cut by cook	1319	SC2 + SVD	BIN cut by cook
1275	GRL	BIN cut by cook	1320	SC2 + SVD	BIN cut by cook
1276	GRL	BIN cut by cook	1321	SC2 + SVD	BIN cut by cook
1277	GRL	BIN cut by cook	1322	SC2 + SVD	BIN cut by cook
1278	GRL	BIN cut by cook	1323	SC2 + SVD	BIN cut by cook
1279	SC2 + OSO	BIN cut by cook including bone in	1324	SC2 + SVD	BIN cut by cook
1280	SC2 + OSO	BIN cut by cook including bone in	1325	SC2 + SVD	BIN cut by cook
1281	SC2 + OSO	BIN cut by cook including bone in	1326	SC2 + SVD	BIN cut by cook
1282	SC2 + OSO + SVD	BIN cut by cook including bone in	1327	SC2 + OSO + SVD	BIN cut by cook including bone in
1283	SC2 + OSO + SVD	BIN cut by cook including bone in	1328	SC2 + SVD	BIN cut by cook
1284	SC2 + OSO + SVD	BIN cut by cook including bone in	1329	SC2 + OSO + SVD	BIN cut by cook including bone in
1285	SC2 + SVD	BIN cut by cook	1330	SC2 + SVD	BIN cut by cook
1286	SC2 + SVD	BIN cut by cook	1331	SC2 + SVD	BIN cut by cook
1287	SC2 + SVD	BIN cut by cook	1332	SC2 + SVD	BIN cut by cook
1288	SC2 + SVD	BIN cut by cook	1333	SC2 + OSO + SVD	BIN cut by cook including bone in
1289	SC2 + SVD	BIN cut by cook	1334	SC2 + SVD	BIN cut by cook
1290	SC2 + SVD	BIN cut by cook	1335	SC2 + SVD	BIN cut by cook
1291	SC2	BIN cut by cook	1336	SC2 + SVD	BIN cut by cook
1292	SC2	BIN cut by cook	1337	SC2 + SVD	BIN cut by cook
1293	SC2 + OSO	BIN cut by cook including bone in	1338	SC2 + SVD	BIN cut by cook
1294	SC2 + OSO	BIN cut by cook including bone in	1339	SC2 + SVD	BIN cut by cook
1295	RST + COM	BIN cut by cook	1340	SC2 + SVD	BIN cut by cook
1296	RST + COM	BIN cut by cook	1341	SC2 + SVD	BIN cut by cook
1297	RST + COM	BIN cut by cook	1342	RST + COM	BIN cut by cook
1298	RST + COM	BIN cut by cook	1343	RST + COM	BIN cut by cook
1299	RST + COM	BIN cut by cook	1344	RST + COM	BIN cut by cook
1300	RST + COM	BIN cut by cook	1345	RST + COM	BIN cut by cook
1301	RST + COM	BIN cut by cook including bone in	1346	RST + COM	BIN cut by cook
1302	RST + COM	BIN cut by cook including bone in	1347	RST + COM	BIN cut by cook
1303	RST + COM	BIN cut by cook including bone in	1348	RST + COM	BIN cut by cook including bone in
1304	RST + COM	BIN cut by cook including bone in	1349	RST + COM	BIN cut by cook including bone in
1305	RST + COM	BIN cut by cook including bone in	1350	RST + COM	BIN cut by cook including bone in
1306	RST + COM	BIN cut by cook including bone in	1351	RST + COM	BIN cut by cook including bone in
1307	RST + COM	BIN cut by cook including bone in	1352	RST + COM	BIN cut by cook including bone in
1308	RST + COM	BIN cut by cook including bone in	1353	RST + COM	BIN cut by cook including bone in
1309	RST + COM	BIN cut by cook including bone in	1354	RST + COM	BIN cut by cook including bone in
1310	RST + COM	BIN cut by cook	1355	RST + COM	BIN cut by cook
1311	RST + COM	BIN cut by cook	1356	RST + COM	BIN cut by cook including bone in

Cont.

Pick Summary continued:

PICK	COOK	PRODUCT SOURCE	PICK	COOK	PRODUCT SOURCE
1357	RST + COM	BIN cut by cook including bone in	1411	GRL	BIN & Packaging
1358	RST + COM	BIN cut by cook including bone in	1443	SFR	BIN cuts
1359	RST + COM	BIN cut by cook	1444	SFR	BIN cuts
1360	RST + COM	BIN cut by cook	1445	SFR	BIN cuts
1361	RST + COM	BIN cut by cook	1446	SFR	BIN cuts
1362	SC2 + SVD	BIN cut by cook	1447	SFR	BIN cuts
1363	SC2 + SVD	BIN cut by cook	1448	SFR	BIN cuts
1364	SC2 + SVD	BIN cut by cook	1449	SFR	BIN cuts
1365	SC2 + SVD	BIN cut by cook	1450	SFR	BIN cuts
1366	SC2 + SVD	BIN cut by cook	1451	SFR	BIN cuts
1367	SC2 + SVD	BIN cut by cook	1452	SFR	BIN cuts
1368	SC2 + SVD	BIN cut by cook	1453	SFR	BIN cuts
1369	SC2 + SVD	BIN cut by cook	1454	SFR	BIN cuts
1370	SC2 + SVD	BIN cut by cook	1455	SFR	BIN cuts
1371	SC2 + SVD	BIN cut by cook	1456	SFR	BIN cuts
1372	SC2 + SVD	BIN cut by cook	1457	SFR	BIN cuts
1373	SC2 + SVD	BIN cut by cook	1458	SFR	BIN cuts
1374	SC2 + SVD	BIN cut by cook	1459	SFR	BIN cuts
1375	SC2 + SVD	BIN cut by cook	1460	SFR	BIN cuts
1376	SC2 + SVD	BIN cut by cook	1461	SFR	BIN cuts
1377	SC2 + OSO + SVD	BIN cut by cook including bone in	1462	SFR	BIN cuts
1378	SC2 + OSO + SVD	BIN cut by cook including bone in	1463	SFR	BIN cuts
1379	SC2 + SVD	BIN cut by cook	1464	SFR	BIN cuts
1380	SC2 + SVD	BIN cut by cook	1465	SFR	BIN cuts
1381	SC2 + SVD	BIN cut by cook	1466	YAK	BIN cuts
1382	SC2 + OSO + SVD	BIN cut by cook including bone in	1467	YAK	BIN cuts
1383	SC2 + OSO + SVD	BIN cut by cook including bone in	1468	YAK	BIN cuts
1384	SC2 + OSO + SVD	BIN cut by cook including bone in	1469	YAK	BIN cuts
1385	SC2 + OSO + SVD	BIN cut by cook including bone in	1470	YAK	BIN cuts
1386	SC2 + OSO + SVD	BIN cut by cook including bone in	1471	YAK	BIN cuts
1387	SC2 + SVD	BIN cut by cook	1472	YAK	BIN cuts
1388	SC2 + SVD	BIN cut by cook	1473	YAK	BIN cuts
1389	SC2	BIN cut by cook	1474	YAK	BIN cuts
1390	SC2	BIN cut by cook	1475	YAK	BIN cuts
1391	SC2	BIN cut by cook	1476	YAK	BIN cuts
1398	GRL	Tested at CSU - Canola & BIN	1477	YAK	BIN cuts
1399	GRL	Tested at CSU - Canola & BIN	1478	YAK	BIN cuts
1400	GRL	Canola & BIN	1479	YAK	BIN cuts
1401	GRL	Canola & BIN	1480	YAK	BIN cuts
1402	GRL	Canola & BIN	1481	YAK	BIN cuts
1403	GRL	Canola & BIN	1482	YAK	BIN cuts
1404	GRL	BIN & Packaging	1483	YAK	BIN cuts
1405	GRL	Canola, BIN and CSIRO Seaweed	1484	YAK	BIN cuts
1406	GRL	BIN, CSIRO seaweed and Packaging	1485	YAK	BIN cuts
1407	GRL	BIN & Packaging	1486	YAK	BIN cuts
1408	GRL	BIN & Packaging	1487	YAK	BIN cuts
1409	GRL	BIN & Packaging	1488	YAK	BIN cuts
1410	GRL	BIN & Packaging			

## 9.2 Sous Vide Protocol

### SOUS-VIDE PROTOCOL

VERSION 1.0:

Developed by Alix Neveau, Mary Rooke, Tiffany Ferguson and Rod Polkinghorne, May 26<sup>th</sup> 2017

#### A: CASSEROLE

##### Summary:

The sous-vide protocol is identical to the MSA slow cook (SC2) protocol other than the cooking process. Sample preparation and dimensions are identical (22 cubes each 21x21x21mm or equivalent mass in a vacuum pouch) as are the final holding and serving procedures. A consumer pick may include a mix of SC2, sous-vide and osso bucco samples each held in 1/9 bain marie steamer pans and containing 300 ml of a mild vegetable stock. The bain marie is maintained at 50°C until all product is served.

The sous-vide cooking process utilises a standard bain marie with a Sammic Smart Vide 4 Immersion Circulator mounted in one corner and set to 62.5°C. Sample bags are suspended from an oven rack placed on the bain marie and secured by bulldog clips each with a cord linked to an external ID.

Samples are cooked for 3 hours then chilled in an ice water bath. Post chilling they are held below 4°C until the test session when they are warmed and placed in 300 ml of vegetable broth in 1/9<sup>th</sup> bain marie steamer pans for serving.

##### Preparation:

The required equipment is:

- One bain marie
- Sammic Smart Vide 4 or equivalent (Protocol instructions relate to Sammic).
- Oven rack with minimum of 9 bars within Bain marie width.
- Printed, laminated and cut out sample ID's.
- 18 bulldog clips with cord attached to smaller bulldog clip for sample ID linkage.
- 240v 10amp power supply & extension cord where necessary.
- Elapsed time timer.
- Calibration thermometer.
- Stock pot, sieve, ingredients and stove common to Slow Cook/Casserole protocol.

### **Sample preparation from primal:**

Raw material preparation is identical to the Slow Cook (SC2) protocol specifying the cutting of 22 cubes each 21mm x 21mm x 21mm for each sample. The cubes are to be vacuum packed in a bag that is suitable for heating to 70°C or greater and frozen at the designated days ageing.

### **Sample thawing and preparation:**

- Remove frozen samples for pick 24 hours prior to cooking. Check to ensure Pick number aligns with printed consumer and bain marie labels. Frozen sample labels have SVD for identification.
- \*\*\* Confirm if pick is only sous-vide or a mix with SC2. If cooking methods are mixed earlier thawing of sous-vide may be needed.
- Transfer to refrigerator at 4°C for thawing.
- Cross check Pick sheet to confirm individual sample ID.
- When thawed check that all sous-vide bags retain vacuum seal. Re-bag, vac, seal and re-label if required.

### **Cooking Procedure:**

1. Locate the bain marie in a suitable safe position where it can be left unattended for an extended period.
2. Attach Sammic Smart Vide 4 to the end of the bain marie. For a Jomac bain marie locate the sous-vide unit adjacent to the bain marie switch unit and within the area external to the heating element. (See Figure 1)

**Figure 1. Sammic Smart Vide 4 placement in Jomac bain marie.**



3. Connect to power.
4. Fill with water to cover the top of the last grill opening by 1.5 – 2cms. required depth - 50mm from top for a full load of 18 bags and proportionally higher for lesser number. Water level should be 25mm from the top after adding all bags. Filling with warm water (temperature must not exceed 60°C) will reduce time.
5. Turn sous-vide unit on. (Switch on rear of pedestal) Display should light up.
6. Set to 62.5 degrees. Press SET button once then either – or + button until 62.5°C is displayed. (see Figure 2).

**Figure 2. Control panel for Sammic Smart Vide 4**



7. Set timer to max. Press Timer button and + button until max time (99:00) is displayed.
8. Wait for temperature to reach 62.5°C. (If water is cold bain marie element may also be utilised until temperature approaches 60°C at which point it should be turned off). Place a lid on the top of the available bain marie area to retain heat. The unit will beep when the set temperature has been reached. Press SET to stop the beeping.
9. Attach bain marie sample EQSRef ID labels to bulldog clip at ID end of ID cords and attach the other end with the larger bulldog clip to the sample bag
10. Place the oven rack over an empty bain marie.
11. Assign cook positions on the oven rack bars to ensure different cuts are dispersed and that individual sample bags do not touch bain marie sides or each other (each second bar on common rack spacings). Allocate bags with the shortest ID cords to the rungs closest to the edge of the bain marie and the bags with the longer ID cords toward the centre rungs. One person should detach and hold the bulldog clip from the bag calling out the AUS number while the other person confirms the matching EQSRef from the bag. Slide the bag under the rack and fold the top of the bag over the assigned oven rack bar, setting length to have the bag suspended above the bain marie floor and its' contents below the water level. Secure to the bar with the matching free bulldog clip and hang the cord with ID over the side of the bain marie. Continue for each sample bag.
12. When temperature is stable at 62.5°C one person should carefully lift the rack with all the attached samples while the other person assists by holding the ID clips to avoid them getting wet. Lower samples suspended from the oven rack into the bain marie with the rack placed on top of the bain marie to stabilise bag position taking care to hang the bulldog clips with ID over the sides of the bain marie. Check that sample bag heights are correct. See Figure 3 for rack alignment on bain marie during cooking.



**Figure 3. Rack alignment during sous-vide cooking; sample bags are suspended from the bars.**



13. Temperature will initially fall as cold samples are added. **Record cook start time when 62.5°C is regained** and place foam lid over the rack to reduce evaporation.
14. Make up a batch of standard SC2 broth cooking the vegetable and salt ingredients at a rolling boil for 45 minutes to share with SC2 samples.
15. After 45 minutes at a rolling boil strain the vegetables off and ladle 300 ml of clear hot broth into 1/9 bain marie steamer pans.
16. Periodically check temperature and water level during the cooking period and top up with warm water if required.
17. At 3 hours remove rack and samples from bain marie and place in foam box to drain.
18. Open each sous-vide sample bag and place contents in a 1/9 bain marie pot stocked with 300ml cooled broth. Stir the contents to separate individual cubes. Securely attach the laminated EQSRef label for each sample to the steamer pan lid and place the lid on the pan. When samples are detached from the oven rack be certain to maintain sample ID by retaining cord and bull dog clip linkage.
19. Place the pans in ice water bath for rapid chilling until serving.

### **Preparation for sensory test serving:**

The post cooking routine is essentially as for MSA SC2 slow cook with minor variation.

1. Fill the bain maries with water and commence heating to 50°C allowing adequate time for the broth to reach temperature.
2. Remove chilled bain marie pans from the refrigerator one hour prior to adding to the serving bain maries and allow to come to room temperature before proceeding as for slow cook/casserole protocol
3. A standard consumer test pick may include any combination of standard SC2, sous-vide or osso bucco sample forms. There will be 42 in total for each pick of 60 consumers who will be served either as a single sitting of 60 or as 3 sittings of 20. Once the bain marie pans are loaded all subsequent serving and scoring activities are as listed in the SC2 slow cook protocol.

## **9.3 Combi Roast Moist Heat Protocol**

### **COMBI OVEN ROAST PROTOCOL**

VERSION 1.0:

Developed by Alix Neveau, Mary Rooke, Tiffany Ferguson and Rod Polkinghorne, May 26<sup>th</sup> 2017

#### **Summary:**

The COMBI protocol is identical to the MSA roast (RST) protocol other than the cooking process. Sample preparation and dimensions are identical as are the final holding and serving procedures. A consumer pick may include a mix of COM and RST samples requiring the simultaneous use of two ovens, one with moist and the other dry heat, or be entirely COM.

Samples are cooked in the Combi Oven at 80°C in combination mode until an internal temperature of 65°C is reached when the individual roast is removed from the oven, rested and then blocked and transferred to the keeper and placed in a 1/9 bain marie pan for holding prior to serving.

#### **Preparation:**

The required equipment is:

- One Combi Oven connected to water, a drain and power.
- Oven racks sufficient to hold the number of roasts to be cooked with steam.

- 25mm deep Gastonome trays for each rack.
- Oven proof thermometers or sensor leads to record internal roast temperatures.
- Calibration thermometer.
- Heat resistant gloves (elbow length).
- Tongs to remove cooked roasts.

#### **Sample preparation from primal:**

Raw material preparation is identical to MSA dry heat roast protocol which specifies a target dimension of 75 x 75 x 150mm with grain oriented parallel to the 150mm dimension.

#### **Sample thawing and preparation:**

- Remove frozen samples for pick 48 hours prior to cooking. Check to ensure Pick number aligns with printed consumer and bain marie labels.
- Transfer to refrigerator at 4°C for thawing.
- Cross check Pick sheet to confirm individual sample ID.

#### **Cooking Procedure:**

20. Locate the Combi Oven in a suitable safe position and connect, or check connection, to drain and suitable 3 phase power supply.
21. Line the gastronome trays with foil to assist cleaning and place racks within each
22. Set Combi Oven controls to 80°C in combination mode and wait for temperature to be reached.
23. Pin ovenproof ID tags to each roast with a stainless steel trussing pins.
24. Place roasts on racks as specified in the MSA dry roast protocol. In brief roasts are arranged in relation to size to facilitate progressive removal with those likely to cook first (lightest) to the front.
25. Place thermometer or temperature sensor leads centrally in each roast avoiding internal fat seams.
26. Place racks in oven.
27. Monitor internal temperature and when 65°C is indicated check with calibration thermometer and remove when temperature is confirmed.
28. Place in holding pan to rest for a minimum of 10 minutes, recording the time of removal from the oven.

#### **Preparation for sensory test serving:**

The post cooking routine is identical to the MSA RST Protocol. A pick may include any combination of COM and RST samples.

4. Follow standard MSA roast protocol to remove roasts in order after resting, block into final 65 x 65 x 120mm form removing all external surfaces and place within the stainless steel keeper.
5. As per MSA roast protocol place roast and keeper in designated bain marie with the 9 individual pans arranged in alphanumeric order for serving.

**Sensory test serving:**

The serving procedure is identical to MSA dry roast protocol with 5 bain maries utilised, 1 for the initial link round and the remaining 4 for subsequent rounds. Two samples are drawn from each bain marie following a timing chart that rotates bain maries in 15 second intervals. For each sample the specified EQSRef identified pan is identified and the keeper and roast removed. A 10mm slice is taken by passing a filleting knife down the keeper slot and the keeper and remaining roast returned to the bain marie. The removed slice is halved and served to the designated 2 consumers.

## 9.4 Sensory Forms

TPB

TPB

**Thank you for your participation today with our meat tasting**



*Our team is here to help you during your session and make this easy for you.*

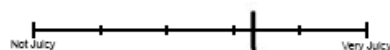
Before you start please listen to the instructions on how to use the scales contained in this questionnaire

Please use a black pen to fill in the form and where asked:

write crosses in boxes like this.....



mark on the line scale like this...



In between each sample please cleanse your palate by:

\* first..... taking a sip of diluted apple juice

\* then..... chew a piece of bread

\* and then.....take another sip of diluted apple juice

**We are after YOUR opinion and therefore ask that you do not talk to anyone else in the room during the research session.**

**Now just a few questions about yourself** (All this information is strictly confidential)

Date



Your Group's Name

\_\_\_\_\_

1. Please write in the boxes the postcode you normally live in

2. Age Group: (Use X in one box only)

18,19 ☐ 20-25 ☐ 26-30 ☐ 31-39 ☐ 40-60 ☐ 61-70 ☐

3. Gender: (Use X in one box only)

Male ☐ Female ☐

4. What is the occupation of the main income earner in your household?:


(Use X in one box only)

- |  |  |
|--|--|
| <input type="checkbox"/> Manager                             | <input type="checkbox"/> Professionals (includes health professional etc.) |
| <input type="checkbox"/> Technicians and Trade Workers       | <input type="checkbox"/> Community and Personal Services Workers           |
| <input type="checkbox"/> Clerical and Administrative workers | <input type="checkbox"/> Sales Workers (includes retail sales etc.)        |
| <input type="checkbox"/> Machinery operators and Drivers     | <input type="checkbox"/> Labourers   |
| <input type="checkbox"/> Home Duties                         | <input type="checkbox"/> Student   |
| <input type="checkbox"/> Other                               |  |

TPB

TPB

TPB

Please use a black pen to fill in the form and write crosses in boxes like this 

TPB

**5. How often do you eat Beef?**

(in any form such as steaks, roasts, stews, casseroles, kebabs, BBQ etc.?)

(Use X in one box only)

- ☐ Daily  
☐ 4-5 times a week  
☐ 2-3 times a week  
☐ Weekly  
☐ Fortnightly  
☐ Monthly  
☐ Never eat beef

**8. When you eat beef, such as steaks, what level of cooking do you prefer?**

(Use X in one box only)

- ☐ Blue  
☐ Rare  
☐ Medium / Rare  
☐ Medium  
☐ Medium / Well done  
☐ Well done

**6.1. How many adults (18 and over) normally live in your household ?**

(Use X in one box only)

- ☐ 1 Adult  
☐ 2 Adults  
☐ 3 Adults  
☐ 4 Adults  
☐ 5 Adults  
☐ 6 Adults  
☐ 7 Adults  
☐ 8 and over adults

**9. What level of income best categorises your combined household income ?**

(Use X in one box only)

- ☐ Below \$ 25,000 per year  
☐ \$ 25,001 - \$ 50,000 per year  
☐ \$ 50,000 - \$ 75,000 per year  
☐ \$ 75,001 - \$ 100,000 per year  
☐ \$ 100,000 - \$ 125,000 per year  
☐ \$ 125,000 - \$ 150,000 per year  
☐ More than \$ 150,000 per year  
☐ Prefer not to say

**6.2 How many children under 18 years normally live in your household??**

(Use X in one box only)

- ☐ 0 Children  
☐ 1 Child  
☐ 2 children  
☐ 3 Children  
☐ 4 Children  
☐ 5 Children  
☐ 6 Children  
☐ 7 and over children

**10. What level of education have you reached? (Use X in one box only for the highest level achieved)**

- ☐ Did not complete Secondary School  
☐ Completed Secondary School  
☐ A College/ TAFE course  
☐ University Graduate

**7 Please read the following statements and use X in one box only for the one statement that applies to you**

- ☐ I enjoy red meat. It's an important part of my diet  
☐ I like red meat well enough. It's a regular part of my diet  
☐ I do eat some red meat although, truthfully it wouldn't worry me if I didn't  
☐ I rarely / never eat red meat

**11. What is your cultural heritage ?**

(Use X in one box only)

- ☐ Australian  
☐ British descent  
☐ European descent  
☐ Asian descent  
☐ Other  
☐ Prefer not to say

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TPB

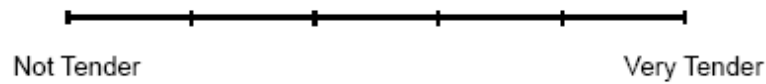
TPB

All information collected in this survey is strictly confidential

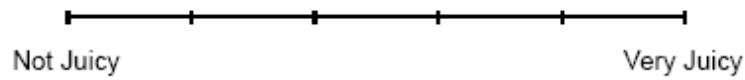
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**PRODUCT:**

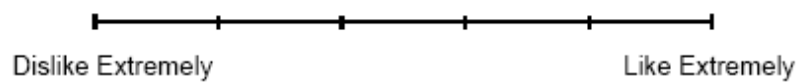
**Tenderness**



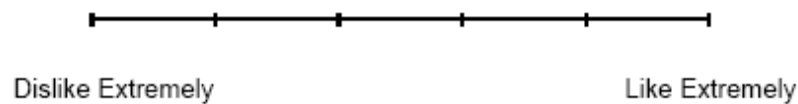
**Juiciness**



**Liking of Flavour**



**Overall Liking**



Please mark **X** in one of the following boxes to rate the quality of the beef sample you have just eaten

Choose one only (you must make a choice)

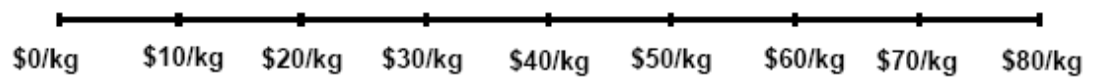
- ☐ Unsatisfactory
- ☐ Good everyday quality
- ☐ Better than everyday quality
- ☐ Premium quality

TPB

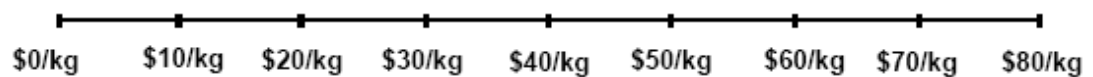
TPB

Based on the beef you have just consumed:  
Please mark the line at the price per Kg you believe best reflects the value for each category.

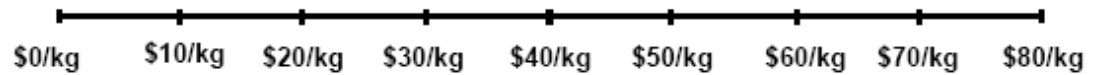
Unsatisfactory Quality



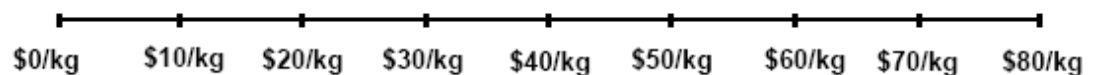
Good Everyday Quality



Better Than Everyday Quality



Premuim Quality



Are you the regular purchaser for your family ? *(Use X in one box only)*

- ☐ Yes  
☐ No