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Primal Block and Extended Aging Sensory Analysis

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Executive summary

Post mortem cut ageing is an important part of the Meat Standards Australia (MSA) prediction model however presents challenges in relation to developing precise estimates due to the interactions with factors such as; animal genetics, muscle calpastatin levels, HGP use, pH and temperature during ageing which are all likely to impact the ageing process.

Current MSA data is extremely limited for cuts aged beyond 35 days. Given the increased volume of Australian beef brands, underpinned by MSA entering export markets, it was viewed that additional ageing data would be of value, in particular relating to muscle ageing at extended days. Related areas of interest were the potential effects of temperature variation and of ageing in a primal form versus ageing as a prepared steak.

This study was undertaken as an additional opportunistic component of a larger trial designed to study potential stress effects on eating quality, utilising 5 muscles at 7 and 21 days ageing. Additional samples were prepared from the same primals and aged for 21 or 42 days in a “block” form, thus simulating primal ageing prior to being fabricated as 5 individual small steaks, as per standard MSA protocol, and frozen. A second set of samples were prepared to standard MSA protocols and subjected to variable temperatures during storage, loosely representative of a domestic butcher shop environment, to evaluate the potential need to differentiate ageing estimates for domestic and export meat.

The base study 21 day aged samples provided a control for comparison to the alternative treatments. Further samples aged beyond 21 days were also prepared and are to be analysed in conjunction with the new 2017 MSA model development. Analysis found no statistically significant difference between the standard MSA ageing protocol to 21 days as a primal “block” versus a prepared steak “slice” and also no impact on ageing from the applied temperature variation.

It should be noted that this was not a shelf life study and that from other studies temperature variation is considered likely to result in reduced shelf life. While the current study is of limited size, the MSA Beef Pathways Committee concluded that the standard MSA preparation protocol adequately relates to beef aged as vacuum-packed primals and that common model ageing estimates can be adopted for export and domestic meat to 21 days.

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1 Background

Post mortem cut ageing is an important part of the Meat Standards Australia (MSA) prediction model, however it is also difficult in relation to developing precise estimates due to the many potential interactions with animal genetics, muscle calpastatin levels, HGP use, pH and temperature during ageing which are all likely to impact the ageing process.

The MSA Beef Pathways Committee discussed the estimation process and inherent challenges and concluded that additional data was of high value with the following factors of high priority:

- Muscle ageing at extended days due to little existing data beyond 35 days and the growing volume of Australian beef brands underpinned by MSA entering export markets.
- Potential impact of ageing in a primal form versus ageing in a prepared steak.

2 Project objectives

The MSA program accounts for approximately 40% of the national adult cattle slaughter, with this proportion increasing year on year. With this ever increasing adoption, brands are utilising the MSA program to underpin both their domestic and export product. As such, in order to maintain industry confidence in the current MSA grading program to predict global consumer satisfaction on product aged longer than 35 days, this research is vital.

The current MSA model is limited to the ability to predict ageing up to 35 days. Any information post 35 days is not sufficient to include in the MSA beef model. Similarly, limited information on the ageing potential of product ageing in a block (primal) vs. slice form is available which has relevance to the increasing preparation of retail ready beef products.

3 Methodology

This study was undertaken as an opportunistic component of a larger study investigating potential stress measures and their possible relationship to eating quality changes in 5 muscles (*M.longissimus dorsi et lumborum* – striploin (STR045), *M.psoas major* – tenderloin (TDR062), *M.semitendinosus* – eye round (EYE075), *M.biceps femoris* - outside flank (OUT005) and *M.infraspinatus* - oyster blade (OYS036)) each aged for 7 and 21 days post slaughter. This work is reported in milestone and final project reports to MLA relating to projects L.EQT.1601 and L,EQT.1618.

Interest in a possible block ageing effect was generated by MSA work in the early 1990's which, on very limited numbers, indicated that samples may age more in "block" form than as individual slices although no scientifically plausible explanation for this had been advanced.

Primal cut portions, surplus to the core trial treatments, were available and utilised to compare ageing in a "block", simulating whole primals, versus ageing as individual 25mm thick slices, as per the MSA grill protocol. The core trial 21 day aged samples were utilised as the control treatment with the difference between the 5 day controls and 21 day aged treatments compared. The primal

cuts were denuded following standard MSA protocols with the 5 day aged and control 21 day aged samples cut from designated muscle positions into five small, notionally 50mm x 75mm, 25mm thick steaks cut across the grain and wrapped in freezer wrap, vacuum packed and aged as a set prior to freezing after 7 or 21 days from slaughter.

An additional portion from each selected muscle, also from a designated position, was vacuum packed as a single "block" large enough to fabricate into an equivalent five steaks after 21 days ageing immediately prior to freezing. The designated positions for each of the core trial 7 and 21 day aged samples and the block were rotated within each muscle to balance out any potential position effects.

The control and "block" samples were held in Styrofoam boxes in close proximity within the same chiller during the 21 day ageing period and all final consumer sample sets frozen immediately after the block fabrication to five steaks.

Further block samples were subject to the same consumer sample preparation process but aged for 42 days. These did not have a direct 42 day control.

Table 1 displays the number of "block samples" evaluated within animal treatment group and muscle.

Table 1: Number of "block" samples evaluated within animal group and muscle.

	EYE ROUND (EYE075)			OUTSIDE FLAT (OUT005)			STRIPLOIN (STR045)			TENDERLOIN (TDR062)			Total
Days Aged	21	42	Total	21	42	Total	21	42	Total	21	42	Total	
Never Mixed Steers	26	11	37	39	12	51	20	14	34	24	7	31	153
Never Mixed Heifers	24	8	32	43	9	52	19	18	37	25	5	30	151
Mixed Steers	12	8	20	17	11	28				15	2	17	65
Mixed Heifers	14	7	21	18	9	27				16		16	64
Mixed Sex	18	5	23	18	12	30	7		7	13	2	15	75
Total	**94**	**39**	**133**	**135**	**53**	**188**	**46**	**32**	**78**	**93**	**16**	**109**	**508**

In addition further muscles were utilised to evaluate the effect of variable temperature on the ageing process to ascertain whether a different MSA ageing estimate could be required for domestic and export meat given that temperature control may be far more variable within a domestic supply chain compared with a shipping container.

Australian export meat (and meat for MSA trials conducted at research facilities) is held at carefully controlled constant temperature for weeks with minimal temperature variation. Australian beef has a well deserved reputation for long shelf life which in part relates to excellent chilling post boning, hygiene standards and a constant -1˚C temperature environment in refrigerated shipping containers. By contrast domestic meat is stored in retail facilities where temperature control is less exacting and more variable as the chiller may be accessed many times per day and retail cabinet displays under lighting can have considerable temperature variation.

Temperature variation, and in particular higher temperatures, is known to decrease shelf life due to more favourable conditions for microbiological growth (Lambert *et.al* 1991). Proteolytic enzyme activity is also known to increase with temperature (Dransfield 1994) creating the scenario that while "domestic" meat may have reduced shelf life it may also have greater short term ageing relative to export.

For this component of the study, additional meat samples, surplus to the same trial, were utilised to compare ageing of meat under variable temperatures with meat that was aged under more controlled temperatures. All control and treated samples were stored as 5 individual standard MSA protocol consumer steaks, individually wrapped in freezer wrap and vacuum packed as a set. Two sets of steaks were designated for 21 days ageing, the first (the core trial control) stored under constant temperature and the second were subjected to variable temperature. These samples were placed on a moveable trolley and rolled out of the coolroom each day for an approximate one hour period for 21 days in order to mimic the variable temperatures the meat may be exposed to in domestic supply chains and retail stores. After 21 days each set of meat samples was frozen. Table 2 displays the number of "domestic samples" evaluated within animal treatment group and muscle.

Table 2: Number of "Domestic" samples within animal group and muscle.

	EYE ROUND (EYE075)	**OUTSIDE FLAT** (OUT005)	**OYSTER BLADE** (OYS036)	**STRIPLOIN** (STR045)	**TENDERLOIN** (TDR062)	**TOTAL**
Never Mixed Steers	8	10	8	8	8	42
Mixed Steers	4	5	4	4	4	21
Mixed Heifers	4	5	4	4	4	21
Mixed Sex	4	5	4	4	4	21
Total	**20**	**25**	**20**	**20**	**20**	**105**

All samples relating to the core trial and cohorts from each muscle were allocated to consumer "picks", each pick being a group of 60 consumers who each sensory evaluated 6 diverse test samples after a common presumed mid position 'link" sample. The six test samples were drawn from each of 6 products with muscle and muscle x ageing used to group into presumed eating quality products, typically with outside flat utilised as a low quality anchor product and tenderloin as a high end anchor with other cuts arranged within products 2 to 5. Standard MSA consumer test protocols resulted in each of the 6 products being presented in accordance with a 6x6 Latin square that ensured each was served an equal number of times before and after each other product and an equal number of times in presentational order from second to seventh. The pick design placed all samples from an individual muscle within a single pick to reduce potential pick effects reducing the effectiveness of ageing comparisons. All muscles tested had a minimum 7 and 21 day aged comparison reflecting the core trial protocol. Other treatments within individual muscles included the "block" versus slice, "domestic" versus MSA standard and ageing to 84 days post mortem. This project reports on only the block and domestic treatments relative to controls from individual common primal cuts.

All consumer testing was conducted within the greater Melbourne metropolitan area by Tastepoint Pty Ltd following MSA grill protocols (Anon 2008).

4 Results

Data files were forwarded to Dr Ray Watson for preliminary analysis of the block and domestic ageing treatments. Further ageing analysis will follow in conjunction with development of the 2017 MSA model and evaluation of the completed shipping and stress trial data. A simple analysis of the variance, as shown in Figure 3, indicates strong significance ($P>0.001$) for both animal and muscle effects but no significant ($P>0.05$) effect of block versus slice ageing.

Source	DF	SS	MS	F	P
animal	162	21975.4	135.7	1.76	0.000
ms	4	185468.7	46367.2	600.26	0.000
trt	1	187.4	187.4	2.43	0.120
Error	1038	80180.2	77.2		
Total	1205	296261.3			

s = 8.789 R^2 = 72.94%

Figure 3: Analysis of Variance for MQ4 with "block" versus slice ageing.

A further simple model with an additional muscle x treatment term indicated that there may be a significant (P>0.007) muscle x treatment effect for the block ageing due to higher eye round values in some animal treatment groups. This was further investigated utilising both covariate and animal models with both approaches producing non significant results.

The detailed analysis was presented to the MSA Beef Pathways Committee meeting on April 18th 2017 and discussed with resulting consensus that there was no convincing evidence of an ageing difference for beef aged in vacuum packaging in block or sliced form to 21 days.

While the number of "domestic" temperature compromised samples was restricted (105 – see Table 2) it was considered that sufficient within animal comparisons existed for preliminary analysis. The analysis result is displayed in Figure 4.

Source	DF	SS	MS	F	P
animal	79	12750.7	161.4	2.17	0.000
ms	4	81676.6	20419.1	274.34	0.000
trt	1	23.2	23.2	0.31	0.577
Error	445	33120.8	74.4		
Total	529	127215.2			

s = 8.627 R-Sq = 73.96%

Figure 4: Analysis of Variance for MQ4 with standard MSA ageing compared to erratic temperature.

As with the block analysis while both animal and muscle effects were highly significant (P>0.001) there was no significant effect for the temperature treatment. Further testing with a muscle x treatment interaction also found no significance with a covariate model producing a similar result. These analyses were also presented to the MSA Beef Pathways Committee on April 18th with agreement as to the analysis approach and result.

The negative outcome for both treatments confirmed that the current MSA model approach, where common individual muscle ageing estimates are applied across supply chains and markets, is valid and the timing of sample preparation in relation to kill and freeze down dates, to attain designated days ageing, can be varied without impacting results. This simplifies the process of both cut preparation and temperature control during sample fabrication.

It should be noted however that all ageing comparisons were conducted with vacuum packed samples and that microbiological tests were not conducted. This was not a shelf life study and it is considered probable that temperature abuse would increase microbiological loads and reduce shelf life. Further studies with a more controlled protocol for temperature variation and accompanied by microbiological testing would be warranted to determine shelf life effects. Further, it is possible that variation could increase beyond 21 days ageing and become significant as ageing is extended.

5 Discussion

This study employed an opportunistic protocol which was unavoidably *ad hoc* and adopted to gain additional value from an extensive and costly primary research project through greater use of available meat and connection to extensive data. While the temperature study in particular utilised only a moderate number of samples the results are regarded as conclusive in relation to ageing as primals or as fabricated consumer samples and also indicative that moderate temperature variation during the sample preparation process or of vacuum packed samples during chilled storage does not appreciably affect the ageing process in the initial 21 day period.

This is convenient in regards to flexibility in trial protocol where the transport times from slaughter to sample preparation can vary and also to some extent allays concern that ageing might be impacted significantly by temperature fluctuation during an extended cut-up or storage period. It also indicates that a varied ageing estimate for beef traded through domestic or export channels is not warranted which simplifies the modelling process although some caution should apply to this observation.

This was not a shelf life study and did not examine potential ageing effects beyond 21 days or ageing in alternative packaging or unpackaged form. In order to understand the microbial differences and longer term ageing effects on shelf life and flavour further study is warranted that uses more controlled temperature variances and durations.

6 Conclusions/recommendations

Analysis found no statistically significant difference between the standard MSA ageing protocol to 21 days as a “block” versus slice and also no impact on ageing from the applied temperature variation. It should be noted that this was not a shelf life study and that from other studies temperature variation is considered likely to result in reduced shelf life. Further studies with a more controlled protocol for temperature variation and accompanied by microbiological testing would be warranted to determine shelf life effects.

While the current study is of limited size the MSA Beef Pathways Committee concluded that the standard MSA preparation protocol adequately relates to beef aged as vacuum packed primals and that common model ageing estimates can be adopted for export and domestic meat to 21 days.

7 Key messages

- The current MSA model is limited to the ability to predict ageing up to 35 days.
- Additional ageing data was considered to be of value, in particular relating to muscle ageing at extended days.
- Related areas of interest were the potential effects of temperature variation and of ageing in a primal form versus ageing as a prepared steak which has relevance to the increasing preparation of retail ready beef products.
- A set of samples were aged 21 or 42 days in a “block” form simulating primal ageing. A second set of samples was prepared to standard MSA protocols and subjected to variable temperatures during storage. A larger ‘base’ study provided 21 day aged samples as a control for comparison to the alternative treatments.
- No statistically significant difference was found between the standard MSA ageing protocol to 21 days as a “block” versus “slice”.
- No impact on ageing from the applied temperature variation was found, however the sample size was limited and the comparison limited to 21 days.
- It is considered prudent in the light of substantial published research to regard temperature variation as a risk relating to reduced shelf life with the further possibility that temperature abuse in the initial 21 day period may have a significant impact on later ageing periods.
- The MSA Beef Pathways Committee concluded that:
    - The standard MSA preparation protocol adequately relates to beef aged as vacuum packed primal.
    - Common model ageing estimates can be adopted for export and domestic meat to 21 days.

8 Bibliography

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