The importance of marbling in the domestic market - what does it mean for consumers?

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Abstract. Australian consumers' attitude to marbling has been influenced by the negative health aspects of fat in the human diet since the 1970s. Lean beef was perceived to have the best eating quality and the best health attributes. Consumer reactions to the appearance of raw beef confimed that Australian consumers preferred beef with the lowest fat trim and lowest marbling. Marbling was perceived to have a larger influence on "fatty meat" than subcutaneous fat. These consumer attitudes to fat deposits were reflected in their purchase intent. There is a distinction between marbling and intramuscular fat (i.e. IMF%). The latter does not accurately measure marbling fat pattern (e.g. flecks) or distribution through the muscle. Consumers do not like unevenly distributed "islands" of fat in muscle. MSA results confirm that up to marble score 3 marbling had a favourable effect on overall eating quality (MQ4 score) of blade, striploin and topside when roasted, and cube roll, striploin and rump when grilled. Australian consumers respond favourably to marbling effects on tenderness, flavour and juiciness even though their visual response to the uncooked product would choose against marbling.

Introduction

Marbling continues to be a contentious issue in the domestic beef market. Why? More than likely because marbling has been lumped into the collective "fat" barrel and animal fats, particularly since the 1970's, have been portrayed in a negative manner with regard to consumer health and well being. Human nature being as it is has responded to the suggestion that if an amount (fat) is bad for health then none (fat) must be really good for human health. The outcome from this response for Australian beef consumers simply hasn't been in their best interests. Some fat, as shown by upwards of 400,000 samples recorded through the MSA testing program, definitely enhances Australian beef consumers' response to their beef eating experience.

Australian Consumers and their Perception of Beef Fat.

In 1992 Polkinghorne and SMART in an ALFA initiated project funded by MRC investigated Australian Beef Consumers response to the raw beef appearance traits. The survey sample comprised 263 consumers from the three eastern seaboard capital cities, Sydney, Melbourne and Brisbane.

Tables 1 and 2 clearly indicate that marbling overrides external fat as a consumer indicator of fat and that liking is inverse to the perceived fat content. In other words as the fat content and more specifically, as this work has shown, marbling, increases then consumer liking decreases.

Table 3 presents perceived eating quality which might be

Table 1. Liking of Raw Appearance (after Polkinghorne).

	Marbling 1	Marbling 2	Marbling 3
2mm External Fat	67	59	44
5mm External Fat	69	64	41
10mm External Fat	49	46	44

Score1 = Dislike Extremely, Score 100 = Like Extremely

Table 2. Perceived Fat Content of Samples (after Polkinghorne).

	Marbling 1	Marbling 2	Marbling 3
2mm External Fat	23	45	66
5mm External Fat	43	53	74
10mm External Fat	67	78	77

Score1 =Not Fatty, Score 100 = Very Fatty

Table 3. Expected/Perceived Eating Quality (after Polkinghorne).

	Marbling 1	Marbling 2	Marbling 3
2mm External Fat	68	59	47
5mm External Fat	68	64	43
10mm External Fat	49	30	19

Score1 =Very Low, Score 100 = Very High

thought to be different to visual attraction. However, the results almost exactly parallel the perceived level of fatness thereby demonstrating that consumers see marbling as detrimental from both a fat content (health?) and quality perspective.

The purchase intent component of the Polkinghorne/SMART study revealed that consumer purchase intent also moves inversely with fat content for both normal and special occasions. This result comes as no surprise given the findings presented in Tables 1, 2 and 3.

Polkinghorne concluded unequivocally from the sensory results relating to raw appearance that consumers dislike fat at any level and believe that very lean beef not only looks more appealing, but will also eat better. Understandably they intend to purchase the leaner less marbled beef for all occasions.

Having seen the response and therefore what marbling means to consumers from the visual perspective, it is important to investigate what marbling means to them when they eat samples of the same marble scores as those evaluated in the visual trial. However, prior to launching into the eating responses it is important to understand more about marbling and to provide a succinct definition of the types of fat consumers do come across when viewing and eating beef.

What is Marbling?

Marbling is one of three fat depots, found in, and /or around, portions of beef as presented at retail or food service outlets, for consumers. The other two depots are known as seam and subcutaneous.

Marbling is the fine evenly distributed flecks of fat found through the muscle. Marbling fat occurs in the spaces between the muscle bundles found within the primal or sub-primal.

Seam fat is that fat found between muscles. Most of you can associate with that fat separating the *longissimus dorsi* (eye muscle) and the *Spinalis* in the Scotch Fillet or cube roll. This is known as seam fat.

Subcutaneous fat is that fat found between the hide and the muscle, it surrounds the muscle, an example is that fat found around the outside of the T Bone or the Striploin.

Marbling is often referred to as intramuscular fat, that is, the fat found within the muscle. It is important not to confuse marbling with intramuscular fat percentage. IMF% is the measure of the total amount of fat found within the muscle, as such IMF% does not take into consideration the fineness of the fat globule nor the distribution of those fat globules through the entire muscle.

Why is it important to make the distinction between marbling and IMF%? The answer is simple, when measuring total amount of fat (IMF%) it is highly probable that large blobs of fat globules unevenly distributed, will be evident. Such a phenomenon detracts from rather than enhances the beef eating experience for the consumer. The consumer preference is for the fat globules to appear as fine flecks and be evenly distributed throughout the muscle. Interestingly the amount of fat present doesn't have to be all that great to provide for consumer satisfaction, given the fine evenly distributed flecks. This is because the consumer ingests some fat with each mouthful and as a result two of the four traits that contribute to the consumers meat quality appreciation score, namely *juiciness* and *flavour* are satisfied. The problem consumers have with portions of beef where the distribution is not even and the intra muscular fat may occur as a large blob, is that when the consumer ingests that mouthful with the large blob of fat in it, an undesirable fat dominated taste sensation results. Such a sensation is characterized by a furry and often lingering taste event that detracts from the consumers overall liking experience. On the other hand when the consumer ingests the mouthful of beef from the portion, where because of the uneven distribution, virtually no fat is present, then a dry less flavoursome taste sensation is experienced. The tiny amounts of fat ingested with each mouthful do help drive the juiciness sensation due to the fact that some fat will stimulate the salivary gland during chewing to keep producing saliva. As a result the mouth is moist throughout the duration of the beef eating experience thereby promoting the juiciness sensation.

Some fat evenly interspersed through the lean or muscle of the beef meal portion has a positive influence on flavour. Again as with juiciness the issue with marbling and its influence on flavour isn't about lots or none, its about optimums, that is, there needs to be enough marbling or "taste fat" ingested with each mouthful to drive the unique beef flavour event but yet not so much as to result in the off flavours associated with excessive fat. Professor Garry Smith, Colorado State University has been credited with describing marbling as "the taste" fat and seam plus subcutaneous fat as the "waste" fat.

Marbling and consumer eating quality response

The question that needs to be asked is "do consumers respond when eating marble score 1, 2 and 3 beef in the same manner as they do when visually appraising the said samples?"

To find the answer it is necessary to visit the MSA sensory evaluation data and subsequent eating quality prediction model. Prior to visiting the data it is important to focus on the premise under which MSA has developed. In essence that premise has been to rigorously and objectively identify the traits that matter in identifying the Australian consumers expectations from eating beef. Then to develop and implement a non-failing delivery procedure from conception to cooking, that is totally outcome based. In other words MSA is about producing beef for the people to eat and enjoy!

While the list of traits set down for testing under the initial

MSA consumer trails totalled 9 and included such traits as "initial bite, texture and sweetness" the four traits that matter to consumers include:

- tenderness
- flavour
- juiciness and
- overall liking.

The contribution of these 4 traits to consumer acceptance for beef has been documented such that tenderness weighting is 40%, flavour 20%, juiciness 10% and overall liking 30%.

Marbling's contribution to flavour and juiciness has already been discussed in the previous section "what is marbling?" Marbling plays a major role in the combined contribution of flavour and juiciness toward overall consumer acceptance. This role cannot be understated given that the combined impact of both juiciness and flavour is only ten percentage points less than tenderness in determining consumer acceptance. That is, the combined contribution from juiciness and flavour is thirty percent toward overall consumer acceptance, while tenderness contributes forty percent.

More work must be carried out to better understand the relationships between the four traits. A current postulation with respect these four traits is as follows; tenderness is paramount in determining fundamental consumer acceptance of beef. Then as tenderness is satisfied the other two traits flavour and juiciness assume greater priority. Therefore given the logic that marbling is a major contributor to both these traits then marbling assumes a greater priority. The overall liking trait which registers thirty percentage points is more than likely used by consumers' as a mechanism to apportion these relative priorities. In other words consumers' do use the thirty points allocated to overall liking to give greater weighting to juiciness and flavour provided of course tenderness expectations are well and truly satisfied. This postulation also helps explain why as marbling levels increase, particularly within the range of marble score 0 to 3, that consumer acceptance also registers an increase.

Tables 4 and 5 illustrate very clearly that marbling does have a positive impact on the eating quality outcome of the major range of beef primals from the "normal" domestic retail type steer. Granted, there certainly aren't all that many three marble score carcases retailed domestically. However, this data does show that if all the other major contributors to eating quality, as determined under the MSA consumer testing procedures, are held constant then marbling does increase consumer acceptance within the range of marble scores 0 to 3, by 4 – 8 points. Interestingly, Topside as a roast is improved from a non-grade to a 3 Star outcome and the cube roll as a grill from a 3 Star to a 4 Star outcome. In all, 9 beef cuts are positively affected by marbling.

How much fat is present within these marble score ranges 0 to 3?

Table 4. A Domestic Retail type body, Achilles hung, steer, 25% *Bos indicus*, 240kg, ossification 160, 5days aged, 7mm rib fat, pH 5.60, meat colour 1c, direct consignment, cook method roast.

AUS-MEAT Marbling	US Marbling	Blade		Striploin		Topside	
		MSA Score	MSA Grade	MSA Score	MSA Grade	MSA Score	MSA Grade
0	200	54	3	47	3	42	X
1	300	55	3	50	3	43	X
2	400	57	3	53	3	45	X
3	500	59	3	56	3	46.5	3

Table 5. Same animal as described in Table 4; cook method grill

AUS-MEAT Marbling	US Marbling	Cube Roll		Striploin		Rump	
		MSA Score	MSA Grade	MSA Score	MSA Grade	MSA Score	MSA Grade
0	200	58	3	48	3	46.5	3
1	300	60	3	50	3	48	3
2	400	63	3	53	3	49	3
3	500	66	4	56	3	51	3

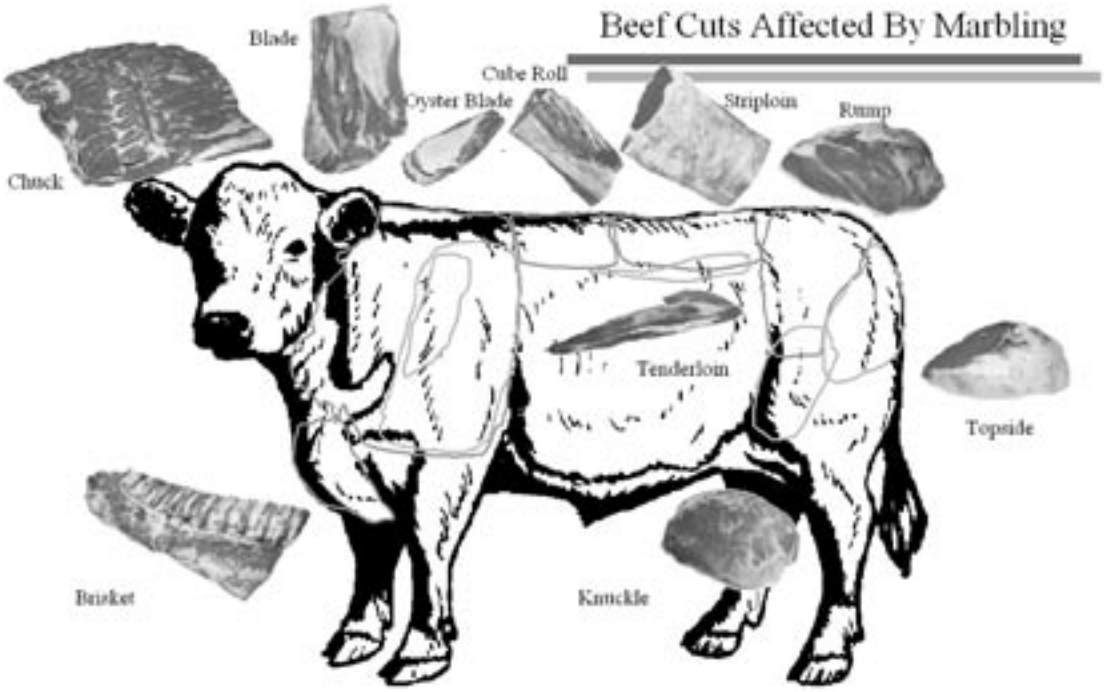

Figure 1. Beef Cuts Affected by Marbling.

Given the problem domestic consumers have with the presence of visible fat and the fact that they seem to prefer eating beef with up to 3 marble score, it is worth attempting to quantify the lipid percentage of the samples outlined in Tables 4 and 5.

Table 6 provides an indication of the lipid percentage for the marble scores 0 to 3. Note that the MSA eating quality prediction model uses USDA marble score due to the fact that consumers respond to the fineness and distribution of the fat within the muscle rather than the total amount. The USDA system measures distribution and fleck more accurately than the AUS-MEAT system and so correlates more accurately with the consumer eating response. The correlations of the AUS-MEAT score with the USDA scores have been made by Phil Green and Jason Strong from MSA and Roy McDonald and Dale Krows from USDA.

It is worth noting that even at the very top of marble score 3 the lipid content is 7%, which is well under the 10% recommended by the National Heart Foundation. So provided the subcutaneous and seam fats are removed marble score 3 beef is able to carry the National Heart Foundation tick thereby putting to rest many of the health fears concerning nutritionists and consumers concerned about their fat intake. Consumers should be encouraged to cook their beef, steaks in particular, with the subcutaneous fat on and then remove it prior to eating.

The Domestic Consumer Marbling Dilemma – What needs to be done?

It's a real conundrum, isn't it? On the one hand consumers are saying they don't like the visual presence of any fat, particularly marbling and on the other hand when they eat it, it's the beef with some marbling that they have a preference for.

The domestic consumer marbling dilemma presents the industry with a range of challenges.

1. For retailers, marketers and human nutritionists. What needs to be done to reassure consumers that some marbling, that is, up to 3 score isn't all that bad for them and in fact will enhance eating quality for them.
2. For Meat Scientists. What needs to be done to ensure the

Table 6. Percentage Lipid as predicted by USDA Marble Score (after Texas A&M Beef Quality Study n= 1,000

AUS-MEAT Marble Score	USDA Marble Score	Lipid Percentage (Based on either extract)
0	100 – 270	0.5 – 2.6
1	280 – 380	2.7 – 4.0
2	390 – 480	4.1 – 5.3
3	490 - 590	5.4 – 7.0

fat percentages currently available are accurate?

What needs to be done to further understand the lipid structure in the three fat groupings, seam, subcutaneous and intramuscular (marbling) particularly with respect levels of saturation and flavour?

What needs to be done with the MSA model and testing procedures to better understand the relationships of marbling to juiciness and flavour?

3. For animal nutritionists and meat scientists. What needs to be done with animal diets to optimise marbling the "taste fat" while reducing seam and subcutaneous fat deposition?

   What needs to be done to manipulate/modify flavour?

4. For animal geneticists, seedstock producers and steer producers. What needs to be done to breed and grow beef animals with a propensity to marble at reduced seam and subcutaneous fat levels?

At the moment marbling certainly has domestic beef consumers confused, they don't like to look at it, but they do like to eat beef with it present, at least to 3 score levels. The challenges marbling presents the industry with are definitely worth pursuing because consumers have continually indicated via focus group and sensory panel sessions that they will eat more and pay more for beef if they can be guaranteed the non failing beef eating experience consistently. Marbling does contribute to this non-failing beef eating experience.

References

Polkinghorne, R. and Scriven, F. (1994) Sensory analysis to determine consumers revealed preferences for beef product description. MRC Project 486, Final Report 11 July 1994. Unpublished Report.