# A QUALITY SURVEY OF BEEF PORTERHOUSE BASED ON PACKAGING, PRODUCT CLAIMS AND PRESENTATION

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**Abstract – This paper describes the outcome of a meat quality survey across various small butchers and retail outlets in an urban area of South Africa and how products, based on presentation, quality claims and packaging, differed in quality. Twenty one porterhouse steaks containing the *M. longissimus lumborum* were collected from the shelves of 13 outlets on 20 different dates over 6 months (n=420) from large retail outlets and smaller butcheries. Warner Bratzler shear force (WBSF), myofibrillar lenth (MFL), fat and meat colour, sarcomere length, collagen properties, dissected fat, and moisture properties were measured. Product categories were determined based on claims for number of maturation days; vacuum packed and claims for maturation, but no specific days; no claims, but vacuum packed; steaks displayed in trays behind counter; steaks displayed on Styrofoam trays overwrapped with PVC; and steaks cut freshly from primals. WBSF with MFL were the major factors separating the product categories. Product categories could give some indication of eating quality (tenderness). In general, products with claimed number of maturation days were the most tender and most consistent, while products that were cut freshly from primals seemed to have undergone the least maturation. Vacuum packaging as such was no guarantee of tenderness.**

**Key Words – Colour, Maturation, Tenderness**

- INTRODUCTION

Consumer criteria for beef quality could be grouped according to the following categories: a) at retail – price, visual appearance; b) at consumption - palatability; c) general considerations about safety of the product, nutritional value and health risks [1]. Tenderness has been identified as the most important palatability attribute of meat for retailers and chefs and, thus, the primary determinant of overall meat quality and consumer satisfaction [2]. Since various factors from the farm gate to the final cooked product affect not only tenderness but also other quality characteristics presenting a consistently high quality product is the culmination of the combined efforts by all role players in the industry to manage all the various quality factors [3]. The beef production chain is still hugely fragmented and so for large parts of the industry the quality of the final product may vary and secondly the reasons for the variation are difficult to trace to a specific sector or role player. Dransfield *et al.* [4] reported a positive relationship between consumers' willingness to pay, and the price combined with knowledge of quality attributes of meat. However, without knowledge of product quality, the consumer has to rely on clues such as appearance of the meat, packaging, price and label information to form an opinion of the product [5].

In this meat quality survey, which took place across various small butchers and retail outlets in an urban area of South Africa, we investigated the relationship between tenderness of similar meat cuts and product presentation, including packaging and quality claims. In addition we determined which quality attributes were relevant to the consumer distinguishing among products and finally attempted to determine the main reason for quality differences by means of histological and physical tests.

- MATERIALS AND METHODS

Twenty one porterhouse steaks containing the *M. longissimus lumborum* were collected from the shelves of 13 outlets on 20 different dates over 6 months (n=420). The samples were collected from large retail outlets (R) and smaller butcheries (B) and all products were from grain fed cattle. Products were presented or purchased as either vacuum packed cuts with claimed number of days matured (DClaim), vacuum packed with claim of aging but duration not specified (GClaim), vacuum packed but no claim of aging (NoClaim), displayed on the shelf in Styrofoam trays with PVC overwrap (Styro), displayed as steaks in trays behind a counter with no over wrap (Displ), or cut into steaks from a primal on request (Primal). Two steaks of each product were purchased at a time and were stored overnight (2°C) before tests on unfrozen or frozen samples were conducted.

Purge was determined as the weight difference between the steak and purge left in the packaging and the dried off steak, expressed as a % of the total weight. Warner Bratzler shear force (WBSF) was performed on fresh steaks oven broiled at 170°C to and internal temperature of 70°C [6]. Shear force was performed on 6 x 12.5 mm (diameter) cores removed from cooked steaks after being cooled down to room temperature (18°C). Cooking losses were calculated as the difference between raw and cooked mass of the steaks. Sarcomere lengths of fresh samples were prepared according to the method of Hegarty *et al.* [7] by using distilled water [8]. Myofibrillar fragment length (MFL) was measured by means of video image analyses (Olympus BX40 system microscope at a 400X magnification) according to Culler *et al.* [9] as modified by Heinze *et al.* [10]. Collagen content and solubility were determined according to the methods of Weber [3], Bergman *et al.* [4], Boccard *et al.* [5] and Hill [6]. Colour recording for meat and fat was with a Minolta meter (Model CR200, Osaka, Japan) following the CIE colour convention using L* (Lightness), a* (redness) and b* (yellowness) as colour components [15]. Non vacuum packed steaks were recorded directly on the surface facing upwards, while vacuum-packed steaks were bloomed for 60 minutes. Data of WBSF were subjected to analysis of variance [16]. Excel 2010 with add-on software XLSTAT was used to perform multivariate analyses (PCA) and draw frequency distributions for scores [10].

- RESULTS AND DISCUSSION

In Table 1 products are presented in order of

Table 1 Number (out of 20) of incidents where the WBS measured above the 95% confidence level, "retail" and "food service" thresholds [18]

| Product | 95% confidence level | Food service threshold | Retail threshold | Mean WBS (kg) |
|---|---|---|---|---|
| | < 3.2 kg | < 3.9 kg | < 4.6 kg | |
| DClaim1 | 10 | 19 | 19 | 3.4[a] |
| DClaim3 | 8 | 14 | 15 | 3.7[a] |
| DClaim2 | 9 | 12 | 15 | 3.7[a] |
| GClaim1 | 10 | 12 | 17 | 3.9[ab] |
| GClaim2 | 7 | 11 | 14 | 4.0[ab] |
| GClaim3 | 3 | 9 | 15 | 4.1[ab] |
| GClaim4 | 5 | 10 | 14 | 4.4[abc] |
| NoClaim3 | 1 | 4 | 10 | 4.8[cd] |
| NoClaim2 | 4 | 6 | 7 | 5.1[cd] |
| Styro2 | 0 | 1 | 6 | 5.2[cd] |
| NoClaim1 | 1 | 5 | 5 | 5.5[cd] |
| NoClaim5 | 0 | 0 | 3 | 5.5[cd] |

| | | | | |
|---|---|---|---|---|
| NoClaim4 | 1 | 2 | 6 | 5.6$^{cd}$ |
| Styro1 | 4 | 6 | 6 | 5.7$^{de}$ |
| Displ2 | 2 | 3 | 5 | 5.7$^{de}$ |
| Primal3 | 2 | 3 | 4 | 5.9$^{de}$ |
| Primal1 | 0 | 1 | 4 | 6.1$^{ef}$ |
| Displ1 | 0 | 0 | 2 | 6.7$^{fg}$ |
| Primal2 | 0 | 0 | 0 | 7.3$^{g}$ |

increasing WBSF and number of samples (out of 20) falling within the threshold limits for retail (< 4.6 kg), Food service (< 3.9 kg) and the 95% confidence limits (< 3.2 kg) reported by Schackelford *et al.* [18]. Products with claimed days of maturation were the most tender and most consistent. Claimed days of aging were between 21 and 28 days for DClaim products. Products with no specific claims but general claims of maturation followed the DClaim products with only 50% of their products within the Food service threshold. Vacuum packed products with no claims of maturation performed poorly with between 0 and 6 samples measuring WBSF < 3.9 kg. Apart from NoClaim3, products with no claims or packed on styrofoam trays or displayed on trays or cut from primals had between 0 and 25% steaks within the Retail threshold (< 4.6 kg). The toughest product had no steaks with WBSF below 4.6 kg.

We used principal component analyses (PCA) to determine which traits separated the product categories. Sixteen variables (Fig. 1) explained

Figure 1. Principal component analyses: Biplots showing scores (treatment groups) and loadings (attributes) for components $F_1$ and $F_2$: (explaining 65.54% of variation among treatment groups)
*DC – Maturation days claimed, GC – Maturation claimed, no days; NC – vacuum packed, no claims; St – Styrofoam tray; Pr – Cut from primal; Dpl –steaks on display*

65.54% of the variation on the first 2 dimensions, F1 (42.75%) and F2 (22.78%). MFL, WBSF, fat a* (redness) and WHC explained the most of the variation on the horizontal axis ($r > 0.8$ with F1). Meat b* and a*, fat b* and moisture explained most of the variations on the vertical axis ($r > 0.6$). It made sense that products on the left side of the y axis were mostly DClaim and GClaim since these products recorded lower WBSF accompanied by shorter MFL's (more matured; [19]) due to long maturation periods. These products were also the most expensive, had fat with higher fat a* values (redder), showed a lower pressed out water (higher WHC) and higher purge and cooking losses. Prolonged aging is expected to produce more free water and purge as a result of structural breakdown of muscle fibre [20]. Redder colour of fat is probably the result of prolonged exposure of fat to meat juices during storage. Dclaim3 separated from the other Dclaim products and the rest of the products due to yellower fat and redder meat and it is possible that these products contained meat from pasture fed animals [21][22]. It is also significant that this product is placed in the opposite quadrant to the collagen solubility variable.

Since WHC, MFL and WBSF were the highest contributions to variation on the x-axis, it makes sense that all the Primal products are situated on the far right and also showed the highest WBSF. These products were probably minimally matured and since they were freshly cut, their expressible moisture would have been high (low WHC). These cuts were followed (to the left) by the cuts displayed on stryrofoam trays (Styro) or in a container behind the counter (Displ) and cuts that were vacuum packed with no claims (NoClaim), mostly as presented in Table 1. Figure 1 also associated primal products with higher fat trim that could have been due to processing of the primal cut without further trimming. The amount of purge would also have been a minimum in these products and the overwrapped samples (Styro; Figure 1). We expected shorter sarcomeres to result in tougher meat, while the most tender group recorded the shortest sarcomere lengths. The reason for this phenomenon is that sarcomeres are normally measured on 24 h post mortem samples when the muscle structure is still relatively intact. In this study we measured it on the final product and in the case of e.g. the DClaim products the muscle was

aged for at least 21 days which could have affected the actual sarcomere lengths due to fibre breaks and detachments.

- CONCLUSION

Variations in tenderness of porterhouse steaks among retailers and within products over a period of time were significant and a high incidence of steaks with WBSF higher than the retail threshold level occurred. The main reason for variation seemed to be the lack of maturation. Presentation, packaging and claims gave some indication of expected tenderness especially with particular claims of number of maturation days. In addition to tenderness the price, colour of fat and meat and moisture properties contributed significantly to the distinction between product categories.

ACKNOWLEDGEMENTS

The Analytical Services Laboratory staff of ARC-API, Irene.

REFERENCES

- Egan, A. F., Ferguson, D. M. & Thompson, J. M. (2001). Consumer sensory requirements for beef and their implications for the Australian beef industry. Australian Journal of Experience Agriculture 41: 855–859.
- Miller, M. F., Huffman, K. L., Gilbert, S. Y., Hammon, L. L. & Ramsey, C. B. (1995). Retail consumer acceptance of beef tenderized with calcium chloride. Journal of Animal Science 73: 2308.
- Ferguson, D. M., Bruce, H. L., Thompson, J. M., Egan, A. F., Perry, D. & Shorthose, W. R. (2001). Factors affecting beef palatability - farm gate to chilled carcass. Australian Journal of Experience Agriculture 41: 879–891.
- Dransfield, E., Zamora, F. & Bayle, M-E. (1998). Consumer selection of steaks as influenced by information and price index. Food Quality Preference 9: 321-326.
- Bernués, A., Olaizolab, A. & Corcoranc, K. (2003) Extrinsic attributes of red meat as indicators of quality in Europe:an application for market segmentation. Food Quality and Preference 14: 265–276.
- AMSA. (1995). Research Guidelines for Cookery, Sensory Evaluation of Meat and Instrumental Tenderness Measurements of Fresh Meat. Chicago. Illinois. National Livestock and Meat Board.
- Hegarty, P. V. J., & Naudé, R. T. (1970). The accuracy of measurement of individual skeletal muscle fibres separated by a rapid technique. Laboratory Practice 19: 161-163.
- Dreyer, J. H., Van Rensburg, A. J. J., Naudé, R. T., Gouws, P. J., & Stiemie, S. (1979). The effect of chilling temperatures and mode of suspension of beef carcasses on sarcomere length and meat tenderness. South African Journal of Animal Science 9: 1-9.
- Culler, R. D., Parrish, F. C., Smith, G. C., & Cross, H. R. (1978). Relationship of myofibril fragmentation index to certain chemical, physical and sensory characteristics of bovine longissimus muscle. Journal of Food Science 43: 1177-1180.
- Heinze, P. H., & Bruggemann, D. (1994). Ageing of beef: Influence of two ageing methods on sensory properties and myofibrillar proteins. Sciences Des Aliments 14: 387-399.
- Weber, R. (1973). The determination of hydroxyproline and chloride in meat and meat products: Simultaneous operation with nitrogen and phosphorus determinations. Technicon International Division SA, Technical Report 7.
- Bergman, I. & Loxley, R. (1963). Two improved and simplified methods for the spectrophotometric determination of hydroxyproline. Analytical Chemistry 35: 1961-1965.
- Boccard, R. L, Naudé, R. T., Cronjé, D. E., Smith, M. C., Venter, H. J. & Rossouw, E. J. (1979). The influence of age, sex and breed of cattle on their muscle characteristics. Meat Science 3: 261-280.
- Hill, F. (1996). The solubility of intramuscular collagen on meat animals of various age. Journal of

Food Science 31: 161-166. Irie M, Izumo A and Mohri S 1996. Rapid method for determining water-holding capacity in meat using Video Image Analysis and simple formulae. Meat Science 42: 95-102.

- MacDougall, D. B. (1977). Colour in meat. In: Birch, G. G., Brennan, J. G. & Parker, K. (Eds.), Sensory properties of foods Applied Science Publishers, London, pp. 59.
- Payne, R. W., Murray, D. A., Harding, S. A., Baird, D. B. & Soutar, M. (2007). GenStat for Windows® (10th Edition) introduction. Hemel Hempstead, UK: VSN International.
- XLSTAT, Version 2011 (Addinsoft to Microsoft Excel 2010, New York, USA).
- Shackelford, S. D., Morgan, J. B., Cross, H. R. & Savell, J. W. (1991). Identification of threshold levels for Warner-Bratzler shear force in beef top loin steaks. Journal of Muscle-Foods 2: 289-296.
- Olson, D. G., Parish, F. C., & Stromer, M. H. (1976). Myofibril fragmentation and shear resistance of three bovine muscles during post-mortem storage. Journal of Food Science 41: 1036–1041.
- Boakye, K. & Mittal, G. S., (1993). Changes in pH and water holding properties of Longissimus dorsi muscle during beef ageing Meat Science., Volume 34, pp. 335-349.
- MacDougall, D. B. (1986). The chemistry of colour and appearance. Food Chemistry 21: 283-299.
- Ripoll, G., Joy, M., Munoz, F. & Albert P. (2008). Meat and fat colour as a tool to trace grass-feeding systems in light lamb production. Meat Science 80: 239–248.