COMPARISON OF SENSORY PROFILES OF BOVINE MUSCLES (LD, GM, ST) USING TRADITIONAL AND RAPID ANALYSIS MAPPED WITH AFFECTIVE TESTING

S.S. Coyle [1], M.G. O'Sullivan [1], A.P. Moloney[2] and J.P. Kerry [1]*

[1]The Food Packaging Group, School of Food and Nutritional Sciences, University College Cork.
[2]Teagasc, Animal and Grassland Research and Innovation Centre, Grange, Dunsany, Co. Meath, Ireland.

* Corresponding author, Tel + 353-21-4903798; fax: + 353-21-42-70001; E-mail address: joe.kerry@ucc.ie

Abstract – The objective of this study was to compare two methods for assessing sensory characteristics of bovine muscles (LD, GM and ST) using traditional 8-point hedonic scaling and a method which combines ranking descriptive analysis (RDA) data with hedonic data (sensory acceptance testing). Sensory analysis was carried out using samples of m. longissimus dorsi (LD), m. gluteus medius (GM) and m. semitendinosus (ST) muscles from cross-bred suckler bulls (n=60) randomly assigned to one of four feeding regimes (Table 1) and slaughtered at 16 months of age. The LD was significantly positively correlated to sensory tenderness, overall flavour, overall texture and overall acceptability whereas the ST and GM muscles were negatively correlated. Of the diets investigated, silage plus 5 kg concentrate had the most positive effect on meat quality, while the diet of grazed grass only had a directional positive effect (ns). However, the diet of ad libitum concentrate appeared to have a negative impact on meat quality.

Key Words – Hedonic scaling, Meat quality, Ranking descriptive analysis

I. INTRODUCTION

Male cattle are generally produced as steers at >24 months of age, on grass-based systems [1]. However, recently producers are exploiting the biological advantages of bulls. Bull beef systems are generally based on a high concentrate diet offered indoors. These concentrates are expensive but with the abundant grass growth in Ireland, there is an opportunity to incorporate cheaper grazed grass in a finishing phase. Grazed pasture is considerably cheaper than grass silage or concentrates [2]; it is therefore desirable to investigate the role of grazing in the production of young bulls. Although there is still a need to develop novel cost-effective systems of producing bulls.

The primary objective of this study was to compare four feeding effects (Table 1), on resulting meat quality. Additionally two types of sensory scales were investigated through sensory evaluation; the first from the American Meat Science Association [3, 4] which uses an 8 point hedonic and the second using Ranking Descriptive Analysis (RDA) mapped with sensory acceptance testing (SAT) data using a 10 cm continuous line scale. This was performed to determine if sensory evaluation can be optimised using new rapid sensory methods.

II. MATERIALS AND METHODS

2.1 Animals, diets and sampling

Spring-born suckler bred bulls (Limousin and Charloais) (n=60) were assigned to one of four treatments. The treatments at pasture were: 1) Grass only (GO), or 2) Grass plus 0.5 of predicted dry matter intake offered as concentrates (G50) with indoor treatments offered 3) Grass silage plus 5kg concentrates or 4) *ad-libitum* concentrates. All concentrates were of the same formulation. The first winter diet consisted of *ad libitum* grass silage plus 2kg concentrate daily for 128 days. On day 86 of the winter, two treatment groups that were assigned to remain indoors, began their 121 day finishing treatments. At the end of the winter, the remaining animals were turned out to pasture where they rotationally grazed a *Lolium perenne* dominant sward for 79 days. These animals

remained at pasture until slaughter at 16 months of age.

2.2 *Sensory analysis*

Meat was obtained, aged and frozen before analysis. Steaks (2.54cm thick) were defrosted at 4˚C for 24 hours and cooked at 200˚C in an electric Zanussi oven to a core temperature of 72˚C. Samples were served immediately to a panel of ten naïve assessors. Each panelist rated the sensory qualities of the samples generated during the course of the project according to the methodology of the American Meat Science Association [3, 4]. The panelists rated five sensory qualities on a scale (8-point hedonic) from 1–8 for tenderness (3–5 chews) where 1=extremely tough and 8=extremely tender, overall flavour where 1=very poor and 8=extremely good, overall firmness where 1=extremely mushy and 8=extremely firm, overall texture where 1=very poor and 8=extremely good and overall acceptability where 1=not acceptable and 8=extremely acceptable.

In a different session, sensory acceptance testing was conducted using ten naïve assessors [5, 6]. The experiment was conducted in panel booths, which conformed to International Standards [7]. A 10cm continuous line scale was used to quantify hedonic attributes (appearance, flavour, texture and acceptability). Liking of appearance, flavour, and texture were rated from extremely dislike to extremely like, and overall acceptability from extremely unacceptable to extremely acceptable. These assessors then participated in ranking descriptive analysis (RDA) [8] using a consensus list of sensory descriptors (firmness, juiciness, toughness, meat-flavour intensity and off-flavour) in which was also measured on a 10cm line scale. Firmness was rated from extremely soft to extremely firm; juiciness, from not juicy to extremely juicy; toughness, from extremely tender to extremely tough; meat flavor intensity and off-flavour, from none to extreme. All samples were presented in duplicate [9].

2.3 Statistical analysis

Data was analyzed using *Analysis of variance* partial least squares regression (APLSR). The software program was the Unscrambler X 10.3.

III. RESULTS AND DISCUSSION

From the analysis of data from the 8-point AMSA scale (Table 1) the LD muscle was found to be positively (P≤0.05) correlated for tenderness, overall flavour, overall texture and overall acceptability. Furthermore, ST was negatively (P≤0.05) correlated for overall flavour, overall texture and overall acceptability. The diet consisting of silage plus 5 kg of concentrates was found to be positively (P≤0.05) correlated for tenderness, overall flavour, overall texture and overall acceptability whereas the diet consisting of ad libitum concentrate was positively correlated for firmness. The diet of G50 was found to be negatively correlated for tenderness. The GO diet showed to be negatively correlated for overall firmness.

Table 1. Mean scores and standard deviations of the sensory attributes of three muscles (LD, GM, and ST) from Charolais and Limousin cross-bred bulls fed on 4 different diets using an 8-point hedonic scale.

Table 1. Muscle type/diet	Tenderness	Overall Flavour	Overall Firmness	Overall Texture	Overall Acceptability
Longissimus dorsi	4.81±1.7***	5.46±1.3***	5.15±1.4^{NS}	5.08±1.4***	5.22±1.4***
Gluteus medius	4.30±1.8^{NS}	4.68±1.4^{NS}	5.50±1.3^{NS}	4.45±1.6^{NS}	4.55±1.5^{NS}
Semitendinosus	4.07±1.7^{NS}	4.71±1.4^{-}*	5.26±1.5^{NS}	4.28±1.5^{-}**	4.39±1.5^{-}**
Silage+5kg	5.30±1.4***	5.74±1.2***	5.19±1.3^{NS}	5.45±1.2***	5.60±1.2***
Ad libitum	4.39±1.7^{NS}	4.97±1.4^{NS}	5.38±1.4***	4.63±1.5^{NS}	4.72±1.5^{NS}
Grazed grass+0.5	4.27±1.6^{-}**	5.13±1.4^{NS}	5.08±1.4^{NS}	4.72±1.5^{NS}	4.86±1.4^{NS}
Grass only	4.61±1.8^{NS}	5.22±1.4^{NS}	4.69±1.4^{-}***	4.81±1.5^{NS}	5.03±1.5^{NS}

P-Values are from the estimated regression coefficients from ANOVA-Partial least squares regression (APLSR) for sensory data acquired using the method of AMSA (1995; 2005). The sign dictates whether the correlation is positively (e.g. **) or negatively correlated (e.g. $^{-}$**).
Significance of regression coefficients:
NS =not significant
*95% significance, P≤0.05
**99% significance, P≤0.01
***99.9% significance, P≤0.001

Table 2 and Table 3. Mean scores and standard deviations of the sensory attributes of three muscles (LD, GM, and ST) from Charolais and Limousin cross-bred bulls fed on 4 different diets using a 10cm line scale (RDA+SAT).

Table 2. Muscle type/diet	Appearance	Flavour	Texture	Acceptability
Longissimus dorsi	6.43±1.8*	5.90±2.0^{NS}	5.51±2.2^{NS}	5.83±2.0^{NS}
Gluteus medius	5.90±2.2^{NS}	5.80±1.5^{NS}	5.64±2.0^{NS}	5.73±1.4^{NS}
Semitendinosus	5.35±2.1^{-}*	5.82±1.8^{NS}	4.72±2.0^{NS}	5.18±1.9^{NS}
Silage+5kg	5.46±2.1**	5.30±1.8**	5.49±2.1^{NS}	5.46±1.8^{NS}
Ad libitum	5.75±2.2^{NS}	5.87±1.9^{NS}	4.98±2.1^{NS}	5.32±1.9^{NS}
Grazed grass+0.5	6.69±1.7^{NS}	5.90±1.9^{NS}	5.70±2.2^{NS}	5.92±1.9*
Grass only	6.65+±1.4^{NS}	6.17±1.9^{NS}	5.48±2.2^{NS}	6.13±2.0*

Table 3. Muscle type/diet	Firmness	Juiciness	Toughness	Meat flavour intensity	Off-flavour
Longissimus dorsi	5.22±2.4^{NS}	5.57±2.4***	4.69±2.5^{NS}	5.77±1.9***	1.14±1.8^{NS}
Gluteus medius	5.88±1.7^{NS}	3.94±2.0^{-}***	5.20±1.7^{NS}	5.16±1.6^{-}***	0.79±1.5^{NS}
Semitendinosus	6.63±1.9^{NS}	3.71±2.0^{-}***	6.12±1.7*	5.23±1.7^{NS}	1.64±1.9^{NS}
Silage+5kg	4.84±2.2^{-}*	5.32±2.4^{NS}	4.37±2.4^{NS}	5.24±1.9*	1.19±1.7^{NS}
Ad libitum	6.41±1.9***	4.50±2.4^{NS}	5.72±2.0*	5.72±1.8^{-}*	1.56±2.0*
Grazed grass+0.5	5.01±2.4^{-}*	5.71±2.3^{NS}	4.54±2.4^{-}*	5.68±1.9^{NS}	0.86±1.6^{NS}
Grass only	5.12±2.6^{NS}	5.26±2.5^{NS}	4.76±2.5^{NS}	5.63±1.9^{NS}	1.11±1.8^{NS}

P-Values are from the estimated regression coefficients from ANOVA-Partial least squares regression (APLSR). The sign dictates whether the correlation is positively (e.g. **) or negatively correlated (e.g. $^{-}$**). Significance of regression coefficients:
NS =not significant
*95% significance, P≤0.05
**99% significance, P≤0.01
***99.9% significance, P≤0.001

From the analysis of RDA mapped with SAT data (Tables 2 and 3) the LD muscle was positively (P≤0.05) correlated for appearance, juiciness and meat flavour intensity while GM was negatively correlated for juiciness, and meat flavour intensity. ST was negatively (P≤0.05) correlated for appearance and juiciness and positively correlated for toughness. The diet consisting of silage plus 5 kg concentrates was positively (P≤0.05) correlated for appearance, flavour and meat flavour intensity and negatively correlated for firmness. Whereas ad libitum concentrate treatment was positively (P≤0.05) correlated for firmness, toughness and off-flavour and negatively (P≤0.05) correlated for meat flavour intensity. The diet of G50 was found to be negatively (P≤0.05) correlated for firmness and toughness and positively correlated for acceptability. GO was positively (P≤0.05) correlated to acceptability. Both methods showed similarities in results but with additional information provided from the RDA mapped with SAT data.

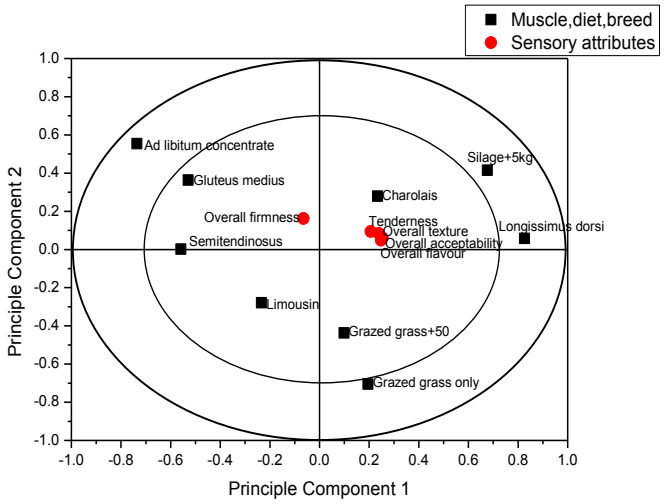

Figure 1. ANOVA-Partial Least Squares regression (APLSR) for muscles (LD, GM, ST) from suckler bulls fed on 4 diets using an 8-point hedonic scale.■=Muscle,diet,breed ●sensory attributes.

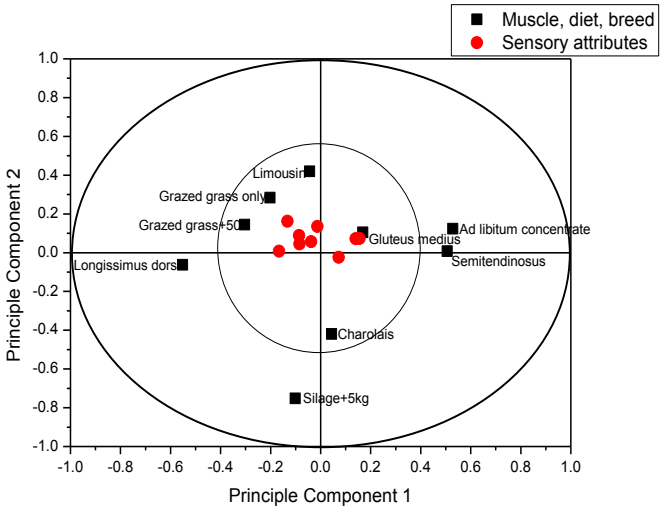

Figure 2. ANOVA-Partial Least Squares regression (APLSR) for muscles (LD, GM, ST) from suckler bulls fed on 4 diets using a continuous line scale.■=Muscle,diet,breed ●sensory attributes.

IV. CONCLUSION

The overall trends of both sensory methods are similar but greater precision and acuity can be obtained using RDA mapped with SAT which is probably because of the use of continuous line scaling allowing greater discrimination paper to assessors for both hedonic and descriptive data. For the various muscles and diets, some significant differences were observed. The LD muscle was significantly more tender than either the GM or ST muscle. The overall flavour, texture and acceptability were also significantly better for the LD muscle. LD had a positive ($P \leq 0.05$) level of significance for juiciness and was 'extremely juicy' compared with the GM and ST muscles which had a negative and high significance for Juiciness and were considered as 'Not Juicy'. The ST was significantly tougher than the LD and GM muscles. With regards to the impact of diet on meat quality, animals on the diet of silage plus 5 kg concentrates appear to produce meat which is significantly more tender, with better overall flavour, overall texture, overall acceptability, better appearance and meat flavour intensity and softer than meat from animals on the other three diets. Animals on the ad-libitum concentrate diet produced meat which was firmer, tougher and had off-flavour and reduced meat-flavour intensity. The diet of grazed grass plus 0.5 predicted dry matter intake offered as concentrate (G50) seemed to produce meat that was significantly less tender than meat produced from the other diets. Lastly, the diet of grazed grass only (GO) was significantly less firm and scored better for acceptability than meat produced from the other diets.

ACKNOWLEDGEMENTS

This work has been performed within the project 'Profitable production of bull beef to market specification while ensuring optimum quality for the consumer'. The financing of the work by the Department of Agriculture, Food and the Marine is gratefully acknowledged.

V. REFERENCES

1. McGee, M (2005). Recent developments in feeding beef cattle on grass silage-based diets. In: 'Silage production and utilisation' . (ed. R.S Park and M.D. Stronge). Proceedings of the XIVth International Silage Conference (a satellite workshop of the XXth International Grassland Congress), July 2005, Belfast, Northern Ireland. Wageningen Academic Publishers, pages 51-64.2.

2. Finneran, E., Crosson, P., O'Kiely, P., Shalloo, L., Forristal, D. and Wallace, M (2012). Stochastic modelling of the yield and input price risk affecting home produced ruminant feed cost. Journal of Agricultural Science, 150, 123-139.3.

3. AMSA (1995). Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago: American Meat Science Association. National Livestock and Meat Board.

4. AMSA (2005). Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago: American Meat Science Association. National Livestock and Meat Board. pp. 4-8.5.

5. Stone, H., Bleibaum, R. N., & Thomas, H. A. (2012a). Affective testing. In H. Stone, B. R.N., & H. . . Thomas (Eds.), Sensory evaluation practices (Fourth, Vol. 4th ed., pp. 291 – 325). USA: Elsevier Academic Press.

6. Stone, H., & Sidel, J. L. (2004). Affective testing. In: H. Stone and J. L. Sidel (Eds.), Sensory Evaluation Practices. Food Science and Technology, International Series. USA: Academic Press/Elsevier., 3rd ed., 247–277.

7. ISO 8589:1988. Sensory analysis-General guidance for the design of test rooms.

8. Richter, V., Almeida, T., Prudencio, S., & Benassi, M. (2010). Proposing a ranking descriptive sensory method. Food Quality and Preference, 21, 611–620.

9. Stone, H., Bleibaum, R., & Thomas, H. (2012b). Test strategy and design of experiments. In H. Stone, Bleibaum R.N., & H. A. Thomas (Eds.), Sensory evaluation practices (Fourth, Vol. 4th ed., pp. 117 – 157). USA: Elsevier Academic Press.