**Review: Beef Eating Quality - A European Journey**

L. J. Farmer and D. T. Farrell

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**Supplementary Tables S1 and S2**

**Table S1. A summary of instrumental research to predict eating quality or parameters which influence eating quality of beef (2000-2017)**

| **Technique** | **Parameters studieda** | **Reference** |
| --- | --- | --- |
| Robotic pH | pH45mins Root Mean Square Error | (Roehe *et al.*, 2014) |
| Computer Vision | Sensory (overall acceptability), WBSF | Jackman *et al.*, 2008) |
| WBSF day 21, Acceptability, Tender, Hard, Juice, Flavour, based on tenderness and acceptability scores | (Jackman *et al.*, 2009) |
| Ultrasound | IMF in lean meat | (Aass *et al.*, 2009) |
| IMF, Marbling | (Indurain *et al.*, 2009) |
| Carcass fat depth | (Roehe *et al.*, 2014) |
| Computerised Tomography (CT scan) | Fat, Muscle, Bone, *Total Carcass tissue* | (Navajas *et al.*, 2010) |
| Cut composition, sensory, IMF, and fatty acid composition | (Prieto *et al.*, 2010) |
| Magnetic Resonance Imaging | IMF | (Lee *et al.*, 2015) |
| Raman Spectroscopy | Acceptability of Aroma, Flavour, Texture, Overall Satisfaction; Intensity of Aroma, Flavour, Tenderness, Juiciness; WBSF  | (Beattie *et al.*, 2004) |
| Near infra-red (NIR) Spectroscopy | WBSF, D14 | (Venel *et al.*, 2001) |
| Fatty acids | (Sierra *et al.*, 2008) |
| Individual fatty acids, SFA, MUFA, PUFA, n-6, n-3, IMF | (Prieto *et al.*, 2011) |
| Fat, protein, moisture | (Su *et al.*, 2014) |
| Visible (VIS) and NIR spectroscopy  | WBSF, *Longissimus dorsi* | (Park *et al.*, 2001) |
| Colour L, a\*, b\*, EChewiness, JuicinessWBSF, Tender/ tough classification (based on predicted/ measured WBSF) | (Liu *et al.*, 2003) |
| Tenderness (Slice Shear Force) | (Shackelford *et al.*, 2005) |
| pH24hrs,Sarcomere length, Cooking loss, WBSF; Colour L, a\*, b\* | (Andres *et al.*, 2008) |
| Colour L, a\*, b\*; Cooking loss %, Volodkevitch Shear Force, Slice Shear Force day 3, Slice Shear Force day 14, Sensory Tenderness, Juiciness, Flavour, Abnormal flavour, Overall Liking | (Prieto *et al.*, 2009) |
| n-3 fatty acids, Conjugated linolenic, Conjugated linoleic, Trans monounsaturated fatty acids | (Prieto *et al.*, 2012) |
| Tenderness (SSF) | (Shackelford *et al.*, 2012) |
| Dark Cutting Beef % correct classification | (Prieto *et al.*, 2014) |
| Beef eating quality (Tenderness-SSF#) | (Qiao *et al.*, 2015a) |
| Hyperspectral imaging | SSF | (Naganathan *et al.*, 2008) |
| Total fat, SFA, Unsaturated fatty acids, Individual fatty acids | (Kobayashi *et al.*, 2010) |
| WBSF; pH48hours; Colour L, a\*, b\* | (Wu *et al.*, 2010) |
| Drip loss (WHC) | (ElMasry *et al.*, 2011) |
| Colour L, Colour b\*; pH, Tenderness (SSF) | (ElMasry *et al.*, 2012 and 2013)  |
|  WBSF, Colour L, a\*, b\* | (Wu *et al.*, 2012) |
| Water, Fat, Protein | (ElMasry *et al.*, 2013) |
| Tenderness (SSF) | (Cluff *et al.*, 2013) |
| Tenderness (SSF) | (Naganathan *et al.*, 2015a) |
| Tenderness, pH | (Qiao *et al.*, 2015b) |
| Tenderness (SSF) | (Naganathan *et al.*, 2015b) |
| Tenderness (WBSF) | (Naganathan *et al.*, 2016) |
| IMF distribution | (Lohumi *et al.*, 2016) |

a pH45mins- pH 45 minutes post-mortem, pH24hours- pH 24hours post-mortem, pH48hours- pH 48 hours post-mortem, SSF = slice shear force, WBSF –Warner Bratzler Shear Force, IMF- Intramuscular fat; SFA- Saturated fatty acids, MUFA- Monounsaturated fatty acids, PUFA- Polyunsaturated fatty acids, n-6- Omega 6 fatty acids, n-3 Omega 3 fatty acids, WHC = water holding capacity,

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**Table S2. Summary of grading systems currently in use to predict beef quality / eating quality (Farmer *et al.*, 2010, Polkinghorne and Thompson, 2010, Bonny *et al.*, 2017)**

| **Grading scheme** | **Country** | **Grading unit** | **Number of grades\*** | **Basis of grading** |
| --- | --- | --- | --- | --- |
| USDA# | USA | Carcase | 8 Quality grades | Sex; carcase weight; marbling; ossification; meat colour, texture; eye muscle area, rib fat; kidney and perirenal fat. |
| Canada | Canada | Carcase | 5 Quality grades (+ subgrades) | Sex; conformation; carcase weight; marbling; meat colour, texture; fat colour, thickness |
| EUROP | Europe | Carcase | 5 Classification grades for conformation and fat (+ subgrades) | Sex; conformation; carcase weight; fat cover. |
| JMGA# | Japan | Carcase | 5 Quality grades  | Sex; carcase weight; marbling; meat colour, brightness, texture; fat colour, lustre, texture, firmness, thickness; eye muscle area, rib thickness.  |
| Korea | South Korea | Carcase | 5 Quality grades | Sex; carcase weight; marbling; meat colour; fat colour, firmness, texture, thickness; lean maturity; eye muscle area, rib thickness. |
| South Africa | South Africa | Carcase | 3 Classification grades (+ subgrades) | Sex; carcase weight; dentition; ribfat; damage. |
| Quality Mark | New Zealand | Carcase | Pass/fail Quality grades | Country of origin; age; handling; absence of growth promoters; licensed plant; ultimate pH |
| MLC# Blueprints (+ updates) | UK | Carcase | Pass/fail Quality grades | Age/sex; growth rate; diet; EUROP grade/fat class; transport and lairage handling; slaughter techniques, defects; hanging; electrical stimulation, chilling and pH/T decline; maturation. |
| Red Tractor and Quality Standard Marks | UK | Carcase | Pass/fail Quality grades | Age/sex;; EUROP grade/fat class; maturation;  |
| AUS-MEAT | Australia | Carcase | Classification grades | Diet; carcase wt; dentition; p\* fat; sex; shape; marbling; meat colour; fat colour. |
| MSA# | Australia | Cut | 3 Quality grades | Bos indicus %; hormonal growth promoter implants; carcass wt; sex; hump height; electrical stimulation; hang; marbling; ossification; meat colour; pHu; ageing time; cooking method. |

\* Classification grades are descriptive terms for the carcase to aid trading while Quality grades aim to place a value on the carcase on the basis of its perceived quality. Grades may also indicate yield (Polkinghorne and Thompson, 2010) but this aspect is not discussed in this paper.

# USDA = United States Department of Agriculture; JMGA = Japanese Meat Grading Association; MLC = Meat and Livestock Commission (now Agriculture and Horticulture Development Board); MSA = Meat Standards Australia.

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