PREDICTION OF AUS-MEAT COLOR AT GRADING BY MEASURING MEAT COLOR USING A NIX PRO COLOR SENSOR

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I. INTRODUCTION

Meat color is an important determinant of consumer acceptance of meat and meat products. However, the perception of meat color is affected by animal and processing factors [1]. Meat color assessment can be done using visual or instrumental approaches. In Australia, meat color of beef carcasses is assessed visually 12- 48 hours post-slaughter using AUS-MEAT standard meat color chips where 1a = palest and 7 = darkest. Meat is graded as dark when meat color score is > 3 [2]. Although this assessment is carried out by AUS-MEAT trained and certified graders, it is still subjective. Instrumental meat color determination, on the other hand, uses colorimeters such as the Minolta and Hunter systems. Although accurate, the ease of use of these machines can be difficult in reduced chiller spaces. Recently, the Nix Pro Color Sensor™ (NIX) colorimeter has become available and is smaller, more affordable, and shock resistant, which downloads data instantaneously to a smartphone app. Its suitability for meat color assessment, being comparable to Minolta and Hunter systems, has been demonstrated [3,4]. The objective of this study was to use the NIX color determination data to develop a prediction model for AUS-MEAT beef color.

II. MATERIALS AND METHODS

Carcass characteristics (kill day, lot number, hot standard carcass weight [HSCW]) and grading data (marbling score, ultimate pH [pHu], and AUS-MEAT color)] of 1146 grain-fed beef carcasses with different chilling periods before grading (12, 24 and 48 h) were obtained from three commercial beef processing plants in New South Wales and Queensland in Australia between September 2017 and February 2018. Carcass grading and meat color assessment was performed after cutting at the quartering site and after at least 30 minutes of blooming. Meat color assessment was done using a NIX (Nix Pro Color Sensor™, Nix Sensor Ltd, Burlington, Ontario, Canada) with 15.0 mm aperture and 45/0° measuring geometry, and using Illuminant D65 and 10° as standard observer settings. Seven measurements were done across the exposed rib eye as described in Holman et al. [4] immediately after visual color assessment. The average CIELAB (lightness [L*], redness [a*], and yellowness [b*]), and LCH (ab) Croma (C*) and Hue Angle (H*) values were obtained for each carcass. AUS-MEAT color scores were grouped into three groups being; Light (1b and 1c), Medium (2 and 3) and Dark (>3). Color grouping at grading was analyzed using a Generalized Linear Model (GLM) in GenStat (GenStat 18, VSN International Ltd, Hemel Hempstead, UK) with a multinomial distribution and logit link function with fitted effects of color values obtained with NIX (L*, a*, b* C*, and H* values, each fitted in a separate model) and ultimate pH along with MSA marbling score, hot standard carcass weight (HSCW) and chilling period. Random factors adjusted for within the model were plant, kill day, lot number and grader. Terms were retained in the model if significant ($P < 0.05$). CIELAB color values were then combined to obtain the best model. Restricted Maximum Likelihood (REML) was used to determine the effect of AUS-MEAT color scores on color values and pHu. Fixed factors were AUS-MEAT color grouping and random factors were as described above.

III. RESULTS AND DISCUSSION

<u>Color grouping analysis;</u> There was a quadratic relationship between L*, a*, b*, and chroma values and AUS-MEAT color scores while there was a linear effect of AUS-MEAT color scores on hue values and ultimate pH

($P < 0.001$ for all, data not shown). Combining color values, the model which explained the greatest deviance percentage in AUS-MEAT color score (28.3 %) was $L^*+a^*+b^*+b^{*2}$. There was no effect of MSA marbling score, HSCW and chilling period on color scores at grading ($P > 0.05$ for all). The positive relationship between visual and objective color determination was in agreement with the previously reported strong correlation between visual and instrumental beef color assessment using the Minolta [5]. REML analysis; Dark color meat (AUS-MEAT score >3) was associated with lower L*, a*, b*, C* and H* values than beef with light or medium color scores (Table 1), which agreed with previous studies using Minolta and Hunterlab [6,7].

Table 1 Effect of AUS-MEAT colour groups (Light, score 1b, 1c; Medium, score 2, 3; Dark, score >3) on the ultimate pH (pHu) and colour values obtained using NIX. The values presented are predicted least squares means and SED.

	Light	Medium	Dark	SED	*P*-Value
pHu	5.51^{a}	5.55^{b}	5.69^{c}	0.010	< 0.001
Lightness (L*)	39.7^{a}	38.1^{b}	34.5^{c}	0.23	< 0.001
Redness (a*)	23.7^{a}	23.7^{a}	20.5^{b}	0.22	< 0.001
Yellowness (b*)	14.8^{a}	14.3^{b}	11.9^{c}	0.14	< 0.001
Chroma (C*)	27.9^{a}	27.7^{a}	23.7^{b}	0.25	< 0.001
Hue Angle (H*)	32.0^{a}	31.2^{b}	30.1^{c}	0.13	< 0.001

The lack of effect of marbling score on meat color determination may demonstrate that the small aperture size of NIX (15 mm) could avoid intramuscular fat and connective tissue that may interfere in color determination [4]. Indeed, this can explain the similarities in a* values between beef with light or medium color scores. The linear relationship between color assessment and pHu agreed with the traditional relationship between color and pHu in beef [2,7]. However, some carcasses were classified as dark-color despite having normal pH. This may indicate that dark-coloured meat in grain-fed cattle is not always accompanied by high pHu, in agreement with Mahmood et al. [8].

IV. CONCLUSION

This study demonstrated that instrumental determination of beef meat color using Nix color sensor provides fast and accurate data which is comparable to the values obtained by accredited AUS-MEAT chiller assessors.

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