RELATIONSHIP BETWEEN AMBIENT CONDITIONS AND COLOUR INDICES OF SOME VARIETY MEATS

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Abstract – The current study describes the relationship between *post-mortem* ambient conditions and colour indices of some variety meats from Dohne Merino sheep. A data logger was used along with colour-guide $45^0/0^0$ colorimeter to generate data on ambient conditions and colour indices of some variety meats from 1 to 30hour post-slaughter. Result showed an inverse relationship ($P < 0.05$) between relative humidity (RH) and the whiteness index (WI) for all the variety meats. The ambient temperature (AT) and dew point (DP) had a strong correlation with the WI of all the examined meats. A negative correlation ($P < 0.05$) was found between RH and the saturation index of the reticulum. While the RH exerted a significant effect ($r = 0.5150$, $P < 0.05$) on the total colour difference of the omasum, the RH and DP at 6hour and 24 hour post-slaughter showed similar effects on colour indices of the meat. It was inferred that the degree of whiteness of the meat was mostly affected by the ambient temperature and dew point of the environment. It was deduced in addition, that the lower the RH, the higher the intensity of whiteness and saturation indices of the meat.

Key Words – Saturation index (SI), Total colour difference (ΔE*), Whiteness index (WI)

- INTRODUCTION

It has been reported that meat purchasing decisions are more influenced by the appearance of the product than any other quality. Thus, colour is perceived to be an indicator of freshness which is of vital importance to the meat industry and consumers as well [1]. Within the Hunter Lab numerical CIELAB or colour-space system, L*; a* or b* coordinate measures the lightness, redness and greenness characteristics of the colour of the sample. These colour-measurement instruments are widely used in the food and meat industries to monitor colour of products such as coffee, tea, cheese, flour and skeletal meat [2, 3]. Due to the fact that some indices are used to communicate values, modifying the *post-mortem* ambient conditions enhances colour indices and acceptability of the variety meats.

Typically in literature [4], colour indices such as the whiteness index (WI) is a preference rating that is a measure which correlates the visual ratings of whiteness for certain white and near-white surfaces. Since colour 'white' is associated with purity, freshness and cleanliness, determination of the WI of the white offal seems relevant for aesthetic value and for utilitarian purposes on white offal. As the saturation index (SI) describes the colour intensity and represents the distance from the black-white axis, colour difference between two measured colours also expresses the difference (Δ) in lightness ($\Delta L^* = L^{*1} - L^{*2}$), redness-greenness ($\Delta a^* = a^{*1} - a^{*2}$), and blueness-yellowness ($\Delta b^* = b^{*1} - b^{*2}$). These provide the difference in the lightness and each of the chromatic dimensions independently of each other [5].

Recent reports have shown that consumers are developing more interest in offal from Dohne Merino sheep as sources of variety meats [6,7]. Despite the growing interest in these variety meats, information is still unavailable on few important colour indices which interrelate with the ambient conditions to boost the colour indices of variety meats which are crucial for

acceptability by consumers. The current study presents a new application of the Hunter Lab numerical CIELAB for measuring the colour of some offal from Dohne Merino sheep.

- MATERIALS AND METHODS

Data collection and determination of ambient conditions

In this study, a total of 138 offal from Dohne Merino castrates (n = 69) and ewes (n = 69) sourced from a high-throughput abattoir were used. From each, sample size weighing 20-40g were excised from the rumen, omasum, reticulum and filet using a sharp scalpel. A data acquisition system was used for logging ambient temperature, relative humidity and dew points of the environment surrounding the offal at 1h, 6h, 24h and 30h post-slaughter. This was done by connecting a data logger (MT668 Major Tech Pvt Ltd, South Africa) with an in-built device for saving data to a laptop computer equipped with Microsoft Excel and programmed to take readings every 60 minutes from 1h to 30h post-slaughter.

Colour measurement of the variety meats

Colour measurements were taken on the surface of fresh offal from Dohne Merino castrates and ewes from 1h, 6h, 24h and 30h post-slaughter under average ambient temperature of 18.65^{o}C, relative humidity of 44.25% and dew point of 4.18. A Minolta colour-guide $45^0/0^0$ colorimeter (BYK-Gardener GmbH, USA) having illuminant D_{65} at 10^o observation angle and 20mm aperture size was calibrated using the green, black and white colour samples to determine L*, a* and b* colour coordinates (Commission International de l' Eclairage, 1976). The colour coordinates obtained was in line with a previous study [8] for:

i. Whiteness index (WI) $=100-\sqrt{(100-L^*)^2 + a^{*2} + b^{*2}}$

ii. Saturation index (SI) $= \frac{\sqrt{a^{*2}+b^{*2}}}{\sqrt{a^{*2}+b^{*2}}}$

iii. Total colour difference (ΔE^*) $= \sqrt{(L_o-L^*)^2 + (a_o-a^*)^2 + (b_o-b^*)^2}$ where subscript 'o' refers to the colour reading of control offal' samples used as the reference and a larger ΔE^* indicates greater colour change from the reference offal' sample.

Statistical analyses

The PROC GLM procedure of SAS was used considering the effects of ambient conditions on the colour indices of the offal. Significant differences between the least square means were performed using the PDIFF test of SAS, with significance level of $p < 0.05$. The PROC CANCORR command of SAS was used to determine the potential multivariate (canonical) relationships among the ambient conditions and colour coordinates of the offal.

- RESULTS AND DISCUSSION

The results presented in Table 1 showed a negative correlation between RH and WI of all the variety meats from Dohne Merino sheep. It was also found that the relationship between the AT and DP produced similar effects on the whiteness index of the rumen, reticulum, omasum and the filet. With respect to the WI for all variety meats, AT and dew points showed strong canonical correlation ($r \geq 0.9$, $P < 0.05$). In Table 2, the AT showed a positive correlation (r =

0.5672, P < 0.05) with the SI of the reticulum.

Table 1 Relationship between ambient conditions, whiteness index and saturation index of some variety meats from Dohne Merino sheep

Variety meats	Ambient conditions	Whiteness index	Saturation index
Rumen	AT	0.9433*	0.1320
	RH	-0.6036*	0.2832
	DP	0.9855*	0.0291
Reticulum	AT	0.9278*	0.5672*
	RH	-0.6067*	-0.0626
	DP	0.9732*	-0.5042
Omasum	AT	0.9261*	0.6116*
	RH	-0.6134*	-0.1000
	DP	0.9739*	0.5455*
Filet	AT	0.9359*	0.2717
	RH	-0.5578*	-0.0635
	DP	0.9714*	0.2276

Key: AT, RH and DP represent ambient temperature, relative humidity and dew point.

Table 2 Relationship between ambient conditions and total colour difference (ΔE*) of some variety meats from Dohne Merino sheep

Variety meats	Ambient conditions	ΔE*
Rumen	AT	-0.3761
	RH	0.3028
	DP	-0.3807
Reticulum	AT	-0.0966
	RH	0.0380
	DP	-0.1010
Omasum	AT	-0.4386
	RH	0.5150*
	DP	-0.4844
Filet	AT	-0.5955*
	RH	0.2758
	Dew point	-0.5889*

Key: AT, RH and DP represent ambient temperature, relative humidity and dew point.

On the contrary, both the AT and DP exerted an inverse correlation (r = -0.5955, P < 0.05) only on the ΔE* of the filet. As shown by the clusters in Fig. 1 within 1hour and 24 hour post-slaughter, the effect of the AT on the colour indices of all the variety meats followed a similar pattern. Both the DP and RH were in Fig. 2 &3 to have similar influence on the colour parameters. Among all the ambient factors, RH showed significant relationship (p < 0.05) with respect to the ΔE* regarding the colour index of the omasum (r = 0.5150*).

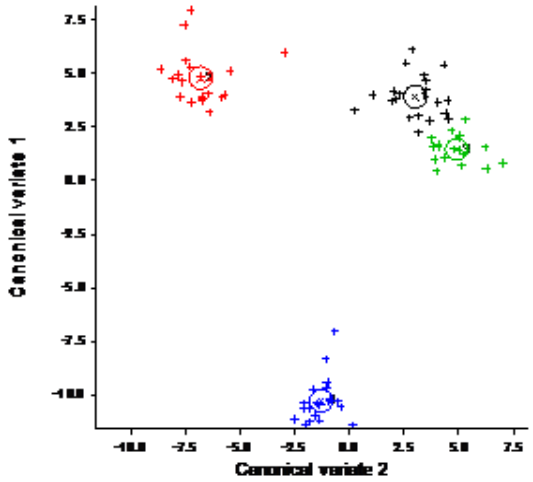

Figure 1. Canonical dimension for relationships between ambient temperature and colour indices of Dohne Merino offals at different post-slaughter timing

Key: 1 (in black), 2 (in red), 3(in green) & 4 (in blue) represents 1h, 6h, 24h & 30h post-slaughter timing

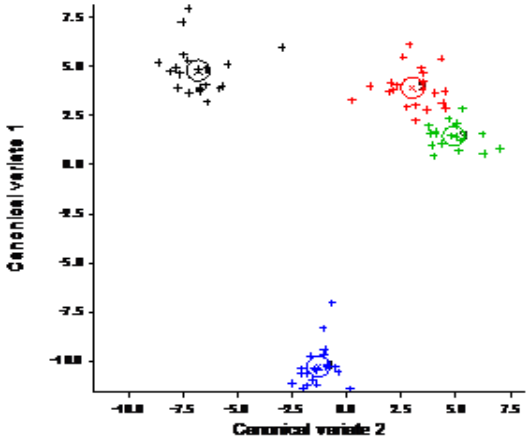

Figure 2 Canonical dimension for relationships between dew points and colour indices of variety meats from Dohne Merino at different post-slaughter timing

Key: 1 (in black), 2 (in red), 3(in green) & 4 (in blue) represents 1h, 6h, 24h & 30h post-slaughter timing

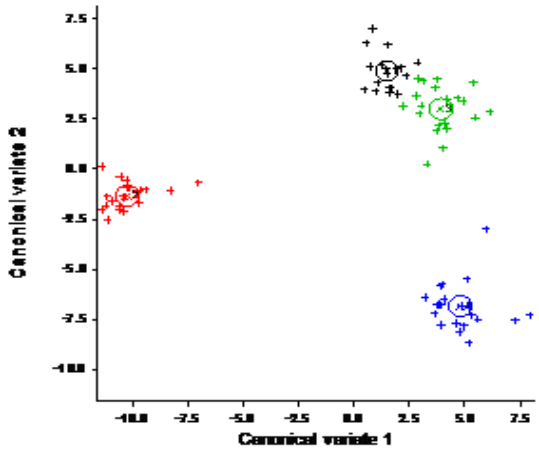

Figure 3. Canonical dimension for relationships between relative humidity and colour parameters of Dohne Merino offal at different post-slaughter timing

Key: 1 (in black), 2 (in red), 3(in green) & 4 (in blue) represents 1h, 6h, 24h & 30h post-slaughter timing

Moreover, the average RH of 44.25% recorded in the present study is within the recommended range of 45-60% for meat packaging, boning and cutting rooms but lower than 80-95% range for meat chilling and ripening [9]. Since RH affects water activity on meat surface in a previous study [10], found that this range of 50-55% RH has the potential of producing desirable whiteness index on some meat parts. This result presupposes that RH of 44.25% and moisture sorption isotherms of the meat might impact on the stability of WI and extension of shelf life of the offal. The extent to which the colour of the variety meats deviated from an ideal white implied that a rise in the relative humidity of the environment has a diminishing effect on the WI of the meat.

- CONCLUSION

It was observed that ambient conditions had higher influence on the whiteness index of most intestinal offal. An inverse relationship was found between the relative humidity and the whiteness index of all the offal. Dew point indicated a negative correlation with the total colour difference (ΔE*) for the fillet.

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