APPLICATION OF COLORMET IN MUSCLE FOOD QUALITY EVALUATION

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SUMMARY

Colormet is a hand-held colour analyzer designed to assist researchers and quality control personnel with objective measurements of visible light reflectance. This instrument is built by Instrumar Engineering Limited of St. John's, Newfoundland, Canada. We used Colormet for assessing meat quality and differentiating between normal and PSE pork. It was noticed that Hunter **L** value was most sensitive as an objective quality indicator for detection of PSE meat. PSE pork muscles generally had **L** values which ranged between 59.5 ± 2.1 and 60.4 ± 0.9 in shoulders and loins, respectively. Hunter **a** values were lower and Hunter **b** values were higher for PSE meats. The content of hemoproteins correlated well with Hunter **L, a,** hue and chroma values ($r = 0.999$). Similar correlations were obtained between pigment content and colour parameters when pigments were extracted into buffer solutions. Thus Colormet analyzers may be used for detection of PSE meat by either direct or indirect method of evaluation.

INTRODUCTION

Colour is the first attribute by which fresh meats are judged and it is an important factor influencing the consumer's decision of purchase (Hood and Riordan, 1973). Myoglobin is the muscle pigment responsible for the various colours in meat. Its concentration depends on many factors such as species of the animal, age, sex, and activity associated with different muscles (Lawrie, 1985). Immediately after slaughter, muscles of healthy animals are relatively dark and dry. However, during postmortem glycolysis, lactic acid accumulation in muscle tissue causes the pH to decline and muscles become brighter and superficially wetter (Swatland, 1989). Both the rate and the extent of pH decline in porcine muscles after slaughter have a profound effect on meat paleness, softness and degree of fluid loss by exudation [PSE] (Bendall and Swatland, 1988). The PSE condition, a heritable trait which is found in hogs susceptible to stress at the time of slaughter (i.e., porcine stress syndrome), is due to lactic acid accumulation which is not removed by the hog's circulatory system before slaughter. PSE meat has less appeal to consumers since it is visually unattractive, the meat requires a longer cooking period and loses excessive moisture resulting in a drier product. Consequently, PSE is universally regarded as a problem in the meat industry since both meat traders and meat processors have become aware of how much even mild PSE is costing them (Bendall and Swatland, 1988). Numerous methods have been developed for detection of PSE condition in pork, however, there is considerable variation between nations in the subjective definitions of PSE (Bendall and Swatland, 1988). Objective sorting by optical methods is possible and may provide a superior method of quality control for premium exports, since it would facilitate standardization and automation (Irie and Swatland, 1992). Irie and Swatland (1992) have stated that currently available subjective and objective methods of analysis for PSE meat is far from perfect; however, there are numerous possibilities on which automated sensors for the predication of pork quality might be based and that the potential combination of light sources, measuring systems and

optical geometry have virtually no limit.

The purpose of this study was to investigate Colormet's potential for differentiating normal and PSE quality pork such that it may possibly be used by processors as a quick, non-destructive technique for assessing meat quality. Furthermore, the relationship between the pigment content from porcine muscles and their respective tristimulus colour parameters was assessed.

MATERIALS AND METHODS

Materials

All chemicals were reagent- or food-grade and were used without further purification. Sodium acetate, potassium ferricyanide and potassium cyanide were supplied by Fisher Scientific Company (Toronto, ON). Loin and shoulder pork cuts were provided by the Newfoundland Farm Products Corporation (St. John's, NF).

Methods

Colour evaluation of randomly selected loin and shoulder pork cuts, chilled for 24 h at 2-4°C after slaughter, was carried out. Initially, PSE and normal quality pork was assessed by visual examination of the meat and then by instrumental means. Tristimulus colour parameters, namely Hunter **L** (lightness/darkness, 100 for white and 0 for black), **a** (red, +; green, -) and **b** (yellow, +; blue, -) values, of the meat surface were recorded using a standard Colormet colorimeter (Instrumar Engineering Limited, St. John's, NF). Data reduction of Hunter **a** and **b** values yielded hue [arctan (**b**/**a**)] and chroma [$(\mathbf{a}^2 + \mathbf{b}^2)^{1/2}$] parameters to be used as possible indices of meat quality. A white colour plate with specifications $\mathbf{L} = 94.5$, $\mathbf{a} = -1.0$, and $\mathbf{b} = 0.0$ was used for calibration. Between 25 and 35 colour measurements were made for each meat cut.

In another set of experiments, fresh loin and shoulder pork muscles were trimmed of all their exterior fat and were ground twice with a 0.79 cm and then a 0.48 cm plate using a Hobart meat grinder (Hobart MFG Co. Ltd., Model 4146, Don Mills, ON). Comminuted meat samples were vacuum packed in polyethylene pouches (Eastern Paper Company, St. John's, NF), and kept frozen at -20°C until used. Total hemoprotein pigment concentration in these samples was determined by the method of Rickansrud and Hendrickson (1967) with slight modifications. Heme pigments were extracted from 20g aliquots of the ground pork into 50 mL of a 0.001 M acetate buffer at a temperature of 4°C and a pH of 4.5. The mixture was homogenized using a Polytron homogenizer (Brinkmann Instruments (Canada) Limited, Rexdale, ON) for 2 min and their contents centrifuged for 15 min at 2000xg. Further extraction of the hemoprotein pigments from the precipitate was carried out using 50 mL of fresh buffer. Samples were homogenized again and centrifuged as described above. Supernatants were combined, filtered by gravity (Whatman No. 3) into a 100 mL volumetric flask and then filled to mark. To a 20 mL aliquot of the heme pigment solution, 1 mL each of 13.2 mM $K_3Fe(CN)_6$ and 17.6 mM KCN solutions were added to form the cyanometmyoglobin/cyanomethemoglobin derivative. Heme pigment concentration, expressed as myoglobin equivalents, was determined spectrophotometrically using a HP 8452A diode array spectrophotometer at a wavelength of 540 nm. Furthermore, visible reflectance measurements of pigment extracts were recorded using Colormet and compared to those

obtained spectrophotometrically.

RESULTS AND DISCUSSION

In Table 1, the mean Hunter **L, a, b,** hue and chroma values of loin and shoulder cuts of both normal and PSE pork, 24 h post-mortem, are assembled. Results indicate that for both loin and shoulder cuts, PSE meats had considerably larger **L** and hue angle values than their normal counterparts. The lighter colour of PSE meats was also reflected in their Hunter **a** values which were always smaller for PSE carcass cuts. However, Hunter **b** values were somewhat larger for PSE meats. Additionally, when Colormet was pressed against PSE-suspect meats for colour evaluation, a substantial amount of exudation was noted. Therefore, it is possible to identify the PSE condition in the meat from either loin or shoulder cuts.

The colour characteristics of comminuted pork samples prepared from PSE pork (0.76 mg myoglobin/g sample), normal pork (1.76 mg myoglobin/g sample) and dark-coloured pork (2.33 mg myoglobin/g sample) were evaluated. As the content of myoglobin in the meat increased, a parallel decrease in Hunter **L** and hue angle values and an increase in Hunter **a, b** and chroma values was noticed (Table 2).

Extraction of hemoproteins by the Rickansrud and Hendrickson (1967) and their subsequent colour evaluations are given in parentheses in Table 2. In all cases examined, a similar trend to that observed in the unextracted meat tissues was noted. Furthermore, the total content of hemoproteins, in all cases, correlated well ($r = 0.999$) with Hunter **L, a,** hue angle and chroma values for both extracted and unextracted pigments.

Table 1. Colour characteristics of normal and PSE pork.[a]

Pork Cut/Quality		Hunter Values[b]				
		L	**a**	**b**	Hue	Chroma
Loin	Normal	49.3±3.6	6.0±2.0	11.9±1.6	63.4±3.6	13.3±1.5
	PSE	60.4±0.9	4.5±0.5	15.3±0.4	73.7±1.6	16.0±0.4
Shoulder	Normal	44.8±3.8	5.6±1.8	9.9±1.1	61.0±7.8	11.5±1.2
	PSE	59.5±2.1	1.2±0.9	10.8±1.3	83.7±5.2	10.9±1.4

[a]Results are mean values of a minimum of 30 readings ± standard deviation.
[b]Hue = Arctan (b/a) and Chroma = $(a^2 + b^2)^{½}$.

Table 2. Dependence of colour characteristics of comminuted pork or extracted pigments on their total homoprotein concentration.[a]

Heme pigment content[b] mg/g	Hunter Values				
	L	**a**	**b**	Hue	Chroma
0.76±0.02	52.6±1.0	7.0±0.9	15.4±0.4	65.7±2.5	16.9±0.5
	(42.7±1.2)	(6.7±0.4)	(23.9±0.6)	(74.4±0.9)	(24.8±0.5)
1.76±0.06	41.1±2.0	13.1±1.6	16.8±0.6	52.1±3.2	21.4±1.0
	(35.9±1.4)	(10.6±0.4)	(25.6±0.3)	(67.6±0.7)	(27.7±0.3)
2.33±0.06	38.7±0.5	17.1±0.8	17.5±1.3	45.7±2.4	24.5±1.0
	(31.5±1.0)	(19.6±0.3)	(29.6±0.5)	(56.3±0.5)	(35.5±0.4)

[a]Results are mean values of at least 10 determinations ± standard deviation. Values in parentheses are for extracted pigments from 20g pork into 100 mL buffer.
[b]Values are expressed as myoglobin equivalents in wet tissues.

In conclusion, objective colour assessment of meats by standard Colormet provides a reliable means for detection of PSE and evaluation of dark coloured meats. The colour values so obtained correlate well with the total content of hemoproteins in the tissues.

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