

COLOUR EXPRESSION IN THE CIELAB COLOUR SCALE OF NEW STILBENE DYES

Grad Maria Elena ^a, Muntean Simona Gabriela ^a, Simu Georgeta Maria ^b

^a*Institute of Chemistry Timisoara of Romanian Academy, B-dul Mihai Viteazul 24, 300223 Timișoara, România*

^b*University of Medicine and Pharmacy "V. Babeș" Timișoara, Faculty of Pharmacy, Eftimie Murgu 2, 300041 Timișoara, România
e-mail:marilena_grad@yahoo.com*

ABSTRACT

Using the well known CIELAB colour space parameters: lightness (L^*), redness (a^*), yellowness (b^*), chroma (C^*) and hue angle (h°) relative to the standard illuminants D65 (natural day light), A (tungsten light), and the standard 10° observer, the colour expression of two new symmetrical direct disazo-stilbene dyes was performed. The colour differences ΔE_{ab}^* and ΔE_{CMC} were calculated against one standard, indicating a high colouring power of the both disazo-stilbene dyes. The studied dyes were synthesized using 4,4'-diaminostilbene-2,2'-disulphonic acid as middle eco-friendly component and 2-methyl-N-acetoacetanilide and 5-acetoacetylaminobenzimidazolone as coupling components respectively.

INTRODUCTION

Colour is extremely subjective and personal. To try to attribute numbers to the brains reaction to visual stimuli is very difficult. The aim of colour spaces is to aid the process of describing colour, either between people or between machines or programs. In 1976 the CIE (Commission Internationale d'Eclairage) recommended the CIE L^*a^*b or CIELAB color scale for use. It was intended to provide a standard, approximately uniform color scale which could be used by everyone so that color values could be easily compared. In a uniform color scale the differences between points plotted in the color space correspond to visual differences between the colors plotted. Over 40 colour difference formulae have been developed since the first CIE colorimetric system. Most of the colour-difference formulae were developed to fit data sets having a limited range of colour-difference magnitudes. [1] In this work the colorimetric analysis by the CIELAB parameters of two new disazo stilbene dyes with symmetrical structure derived from 4,4'-diaminostilbene-2,2'-disulphonic acid is presented.

MATERIALS and METHODS

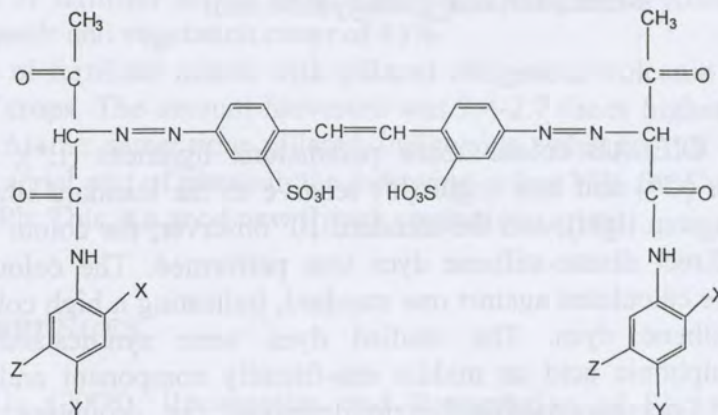
The chemical employed in this study were obtained from S. C. Chimopar S. A., Merck Co., AcrOs Organic Co, Alfa Aesar Co, Monicolor Co. and S. C. Azur S.A. The colour spectrophotometric data of the two new synthesized direct azo-stilbene dyes were recorded on a Minolta 3200d spectrophotometer and the results were performed by CorobQuality 1.5 program.

Four samples which were differentiated by the synthesized direct azo-stilbene dyes and by the white pigment standard (P.W.6) concentrations were layed on a cellulosic substrate. Colours were expressed by the CIELAB analysis of the samples (D65, A

illuminants, and 10° observer). The colour differences ΔE_{ab}^* and ΔE_{CMC} were calculated confronted by the above mentioned white standard.

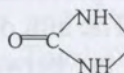
RESULTS

The synthesis of the dyes with the structures **Ia** and **Ib** involved two phases: the bis-diazotisation of 4,4'-diaminostilbene-2,2'-disulphonic acid by indirect method, and the coupling reactions of the resultant bis-diazonium salt with the coupling components: 2-methyl-N-acetoacetanilide (for dye **Ia**) and 5-acetoacetylaminobenzimidazolone (for dye **Ib**)



Ia: X=CH₃; Y=Z=H

Ib: X=H; Y=Z=



Structures of the direct azo-stilbene dyes **Ia** and **Ib**

ΔE_{ab}^* is based on L^* , a^* , b^* colour differences and was intended to be a single number metric for pass/fail decisions.

The human visual system is more sensitive to different kinds of changes and perceives these differences in different magnitudes even though they may have the same calculated difference. For instance, the eye is more sensitive to changes in chroma than changes in lightness. The different color difference equations give weightings in different parts of the color space to better match the differences seen by the human eye.

ΔE_{CMC} is a single number pass/fail measurement that defines a 3-dimensional tolerancing space.

The colours of the obtained samples were expressed by means of the rectangular (L^* , a^* , b^*) and cylindrical (L^* , C^* , h^0) coordinates. The colour differences values calculated by ΔE_{ab}^* and ΔE_{CMC} formulas were compared. The spectrophotometric results obtained using D65(natural day light), and A (tungsten light) illuminants and the standard 10° observer, are shown in tables 1 for dye **Ia** and in table 2 for the dye **Ib**.

Table 1 The spectrophotometric data of the azo-stilbene dye **Ia**

	W	W ₁	W ₂	W ₃	W ₄	
Illuminant	Stand	2%dye	5%dye	8%dye	15%dye	
D65	L*	94.57	88.45	83.18	80.39	78.08
	a*	-0.25	2.54	5.41	8.01	10.62
	b*	1.69	22.20	28.56	33.14	34.17
	C*	1.71	22.35	29.06	34.09	35.78
	h°	1.72	1.46	1.38	1.33	1.27
	$\Delta E_{ab^*}/\Delta E_{CMC}$		21.59/27.87	29.72/37.07	35.47/43.94	38.01/46.34
A	L*	94.67	90.13	85.50	83.20	81.21
	a*	0.37	5.92	9.17	11.60	13.57
	b*	1.50	23.83	31.14	36.59	38.26
	C*	1.54	24.55	32.46	38.38	40.59
	h°	1.33	1.33	1.28	1.26	1.23
	$\Delta E_{ab^*}/\Delta E_{CMC}$		23.46/31.37	32.25/42.22	38.59/50.32	41.31/53.38

Table 2 The spectrophotometric data of the azo-stilbene dye **Ib**

	W	W ₁	W ₂	W ₃	W ₄	
Illuminant	Stand.	2%dye	5%dye	8%dye	15%dye	
D65	L*	94.57	81.41	75.60	70.54	64.52
	a*	-0.25	11.91	17.94	20.82	21.95
	b*	1.69	16.57	23.51	24.23	24.70
	C*	1.71	20.41	29.57	31.95	33.04
	h°	1.72	0.95	0.92	0.86	0.84
	$\Delta E_{ab^*}/\Delta E_{CMC}$		23.30/26.23	34.16/38.73	39.11/42.29	43.88/44.20
A	L*	94.67	83.04	79.08	74.37	68.49
	a*	0.37	12.97	18.74	21.44	22.32
	b*	1.50	20.73	29.62	31.03	31.81
	C*	1.54	24.45	35.05	37.72	38.86
	h°	1.33	1.01	1.01	0.97	0.96
	$\Delta E_{ab^*}/\Delta E_{CMC}$		25.42/31.53	37.03/46.05	41.57/49.89	45.67/51.75

CONCLUSIONS

- The colour expression of two new symmetric disazo-stilbene direct dyes, synthesized using 4,4'-diaminostilbene-2,2'-disulphonic acid as middle component and 2-methyl-N-acetoacetanilide and 5-acetoacetylaminobenzimidazolone as coupling components respectively was performed in the CIELAB colour space
- The spectrophotometric data indicate a high colouring power for the studied disazo-stilbene dyes under the standard illuminants D65 (natural day light), A (tungsten light) and the standard 10° observer respectively

LIST OF REFERENCES

- [1] Schanda J. (2008), *Colorimetry: Understanding the CIE system*, ed. Wiley-Interscience, Hoboken

Table 1 The spectrophotometric data of the disazo-stilbene dye II

Wavelength (nm)	D65	A	D65	A
400	0.02	0.01	0.02	0.01
420	0.03	0.02	0.03	0.02
440	0.05	0.04	0.05	0.04
460	0.08	0.07	0.08	0.07
480	0.12	0.11	0.12	0.11
500	0.18	0.17	0.18	0.17
520	0.25	0.24	0.25	0.24
540	0.32	0.31	0.32	0.31
560	0.40	0.39	0.40	0.39
580	0.48	0.47	0.48	0.47
600	0.55	0.54	0.55	0.54
620	0.62	0.61	0.62	0.61
640	0.68	0.67	0.68	0.67
660	0.73	0.72	0.73	0.72
680	0.78	0.77	0.78	0.77
700	0.82	0.81	0.82	0.81
720	0.85	0.84	0.85	0.84
740	0.87	0.86	0.87	0.86
760	0.88	0.87	0.88	0.87
780	0.89	0.88	0.89	0.88
800	0.90	0.89	0.90	0.89