Effect of Ink Sequence on Print Quality in Offset Printing

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Abstract - Print quality has always been an important aspect and the most exclusively evaluated term in printing. It has been considered of greater significant all over the world in this modern era. The sequence of colors is an important factor effecting print quality in Sheet-fed Offset printing. This research paper delineated the variations in ink density, contrast and L*a*b* values due to different ink sequences. Five different ink sequences CMYK, MYCK, YMCK, KCMY and KYMC were used on Maplitho paper substrate for study. The key objective of this paper is to investigate impact of these sequences on printing parameters on Maplitho paper during printing.

Keywords: Print quality, Ink sequence, Color, Maplitho Paper, Offset Printing.

I. INTRODUCTION

In four-color printing process the process color inks are printed consequently. The order or series in which these process inks are laid down on to the substrate is called printing ink sequence. It is also referred to as the Ink lay down Sequence. In four colors printing processes the process color used are Cyan (C), Magenta (M), Yellow (Y) and Black (K) i.e. key color generally. The ink printed on to the substrate a thin layer of app. (2-4 micron) is printed. Most of the press operators establish and maintain strict sequences for printing each of the colors at their establishments. The sequence is very important due to several practical reasons. The ink sequence is very crucial due to several practical reasons. Many printers prefers for strict print sequences. Many printers prefer standardized print sequence KCMY i.e. respective sequence is Black, Cyan, Magenta and Yellow color. In other system the black color is shifted from first color to fourth color i.e. CMYK ink sequence. Mathematically by using four process colors (Cyan, Magenta, Yellow, and Black) according to counting rule of permutations, then total number of outcomes = 4! i.e. 4*3*2*1 = 24 different ink sequences are possible. Out of these 24 sequences, the study was made on five print sequences. The sequences selected were based on the opinion of predominant industry experts. The order in which the press run was performed YMCK, MYCK, CMYK, KCMY, and KYMC, with the printing units interchanged to change the sequence of inks. These sequences were used in sheet-fed offset printing on Maplitho paper.

II. RESEARCH METHODOLOGY

In order to carry out the research work, first of all a suitable master was prepared. This master was designed with a great care and attention so that a successful research can be done for effective result. The design of master was such that in which the value of density and other values can be measured easily in effective way. In order to find effective results, the following image elements were included in to the test form:-

i. Text matter from 6 point to 36 point to obtain the print quality in all the ranges of black color.

ii. A four color pixel image with 145 LPI resolutions.

iii. Line drawing in black color.

iv. Color control patch with Solid Ink Density, Dot in 25%, 50%, 75% and 100%.

v. Gray scale patch from 0%, 3%, 5%, 10%, 15%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95% and 100%.

vi. Registration marks in order to control better registration in four different positions i.e. left, right, top and bottom of the test form.

The plates were prepared by using CTP (Computer to Plate) system. Technova positive working PS (pre-sensitized) plates were taken for preparing plates reason being these plates are known for their excellent results. Also proper care was taken while handling and storing of plate before, during and after printing for research work. The printing work was carried out in Dora Offset Printing Press, Hisar. The pressroom conditions in the Dora Offset Press were accurate and strictly according to the printing parameters. Then printing was done on Maplitho paper (70 gsm) with five different sequences (CMYK, MYCK, YMCK, KCMY and KYMC). Then density, LAB values, and contrast of different samples were measured with the help of

spectrophotometer. The data so collected was recorded for analysis done with the help of suitable statistical and quantitative method.

III. DATA COLLECTION & ANALYSIS

Maplitho paper (70 gsm) was substrate on which printing was done on by using sheet-fed offset process. Among 24 different printing sequences, five different ink sequences namely CMYK, MYCK, YMCK, KCMY and KYMC were used. The research work was carried out on these five ink sequences. Then LAB values, ink density and contrast of various different samples were measured. Spectrophotometer of series X-Rite 528 was used. The data was noted down for analysis. So collected data was compiled in order to analyse and conclude. The findings of research are presented below:-

Maplitho 70 GSM: Density Value at 90%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.92	1.12	1.28	0.84	0.98
Green	0.72	0.78	1	0.76	0.8
Blue	0.86	0.81	0.8	1.01	0.81
Brown	0.47	0.49	0.51	0.51	0.48
Violet	0.27	0.31	0.3	0.38	0.29
Orange	0.72	0.99	1.07	0.77	0.9
Purple	0.6	0.66	0.6	0.71	0.49

Table 1:- Density value at 90%

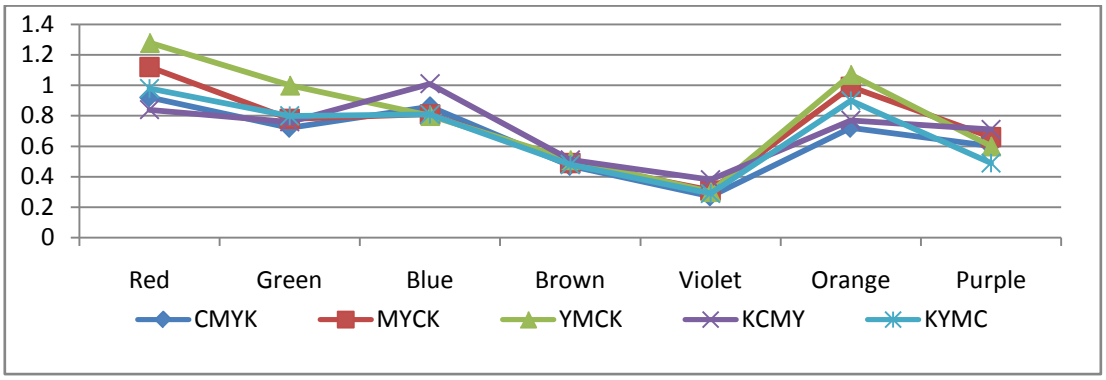

Figure 1: Density values at 90%

The result observed in table 1 and figure 1 expressed that: -

- The value of Ink Density of 'Violet' color is lower in all sequence as compare to other color.
- The value of Ink Density of 'Red' color is higher in all sequence as comparatively to other color.
- The density value of Brown color was almost same in all sequence.

Maplitho 70 GSM: Density Value at 70%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.62	0.72	0.82	0.64	0.64
Green	0.51	0.52	0.69	0.58	0.58
Blue	0.62	0.59	0.61	0.79	0.58
Brown	0.31	0.34	0.38	0.39	0.38
Violet	0.2	0.26	0.21	0.3	0.22
Orange	0.54	0.77	0.77	0.59	0.63
Purple	0.41	0.46	0.48	0.52	0.4

Table 2: - Density value at 70%

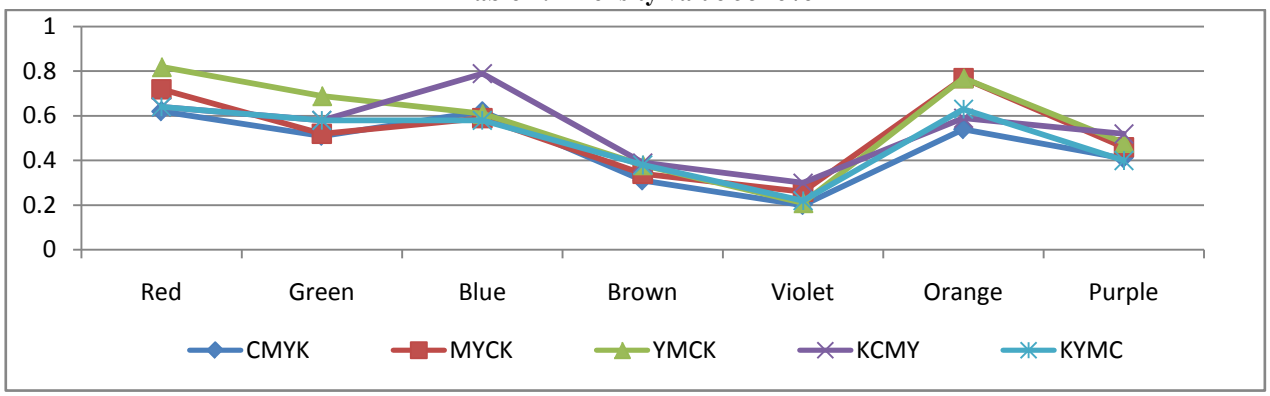

Figure 2: Density values at 70%

The data expressed in table 2 and figure 2 depicted that: -

- Again the value of density of 'Violet' color was lower in all sequences.
- Again the value of density of 'Red' color was higher in all sequence as comparing to other colors.
- The least variation was observed in the density of Brown color in all sequences.

Maplitho 70 GSM: Density Value at 40%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.36	0.47	0.53	0.42	0.45
Green	0.31	0.29	0.43	0.36	0.38
Blue	0.37	0.27	0.38	0.51	0.4
Brown	0.18	0.2	0.22	0.17	0.23
Violet	0.11	0.14	0.12	0.14	0.14
Orange	0.34	0.45	0.5	0.37	0.4
Purple	0.26	0.32	0.31	0.33	0.24

Table 3:- Density value at 40%

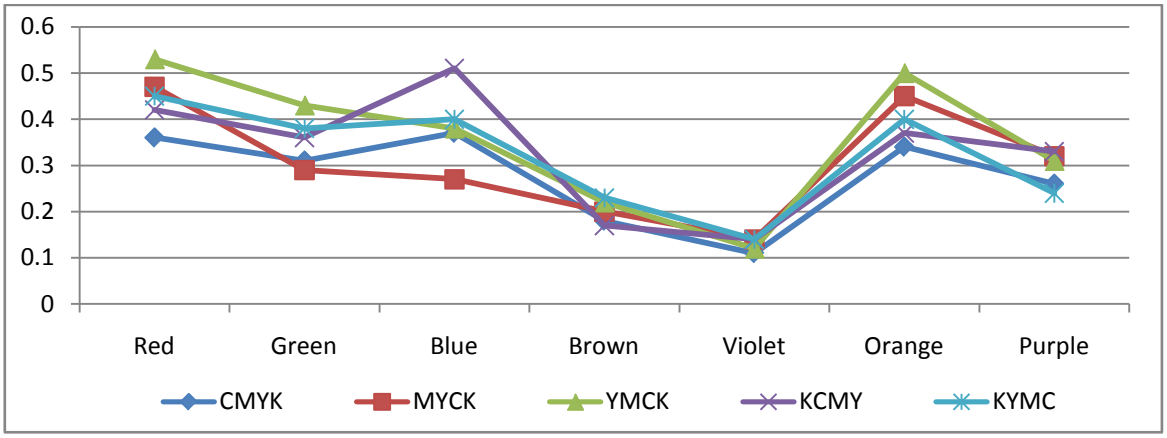

Figure 3: Density values at 40%

The result presented in figure 3 and table 3 depicted that: -

- In all the printing color sequences 'Red' color density was observed in maximum range. On the other hand 'Violet' color density was observed minimum comparatively to other colors.

- The least variation was observed in the density of Violet color in all sequences.

Maplitho 70 GSM: Density Value at 15%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.22	0.26	0.28	0.26	0.24
Green	0.18	0.19	0.23	0.16	0.21
Blue	0.21	0.22	0.23	0.24	0.23
Brown	0.11	0.13	0.12	0.1	0.13
Violet	0.07	0.08	0.07	0.09	0.08
Orange	0.18	0.2	0.25	0.2	0.2
Purple	0.12	0.15	0.17	0.16	0.14

Table 4:- Density value at 15%

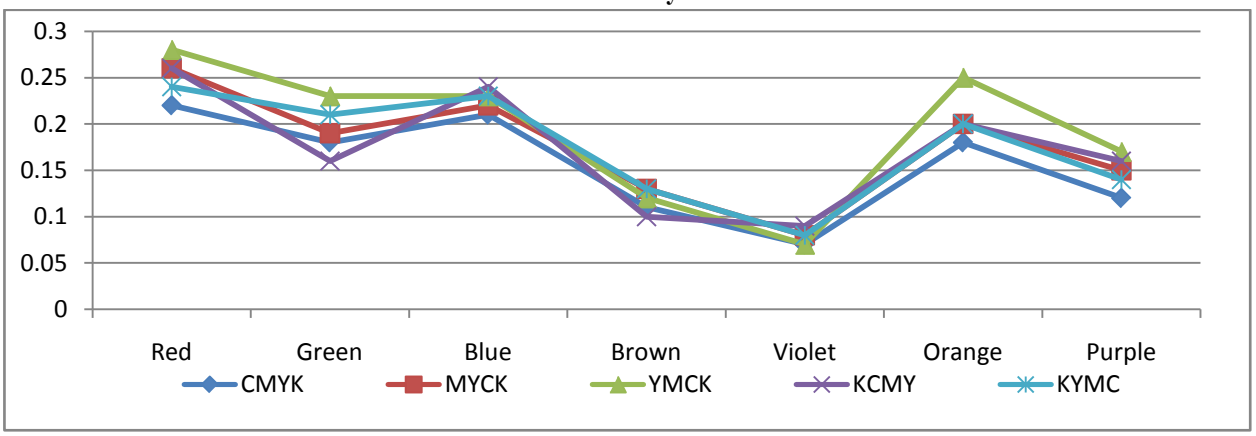

Figure 4: Density values at 15%

The result of the observations of 15% ink density were presented in figure 4 and table 4 which depicted that in all different color sequences 'Red' color density was observed in maximum range. While minimum density was observed for 'Violet' color comparatively to other colors. Also among all sequences 'Blue' color exhibits least variation.

Maplitho 70 GSM: Contrast value at 90%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	22%	19%	17%	21%	23%
Green	26%	28%	20%	32%	24%
Blue	29%	31%	25%	12%	24%
Brown	30%	33%	27%	30%	31%
Violet	29%	26%	26%	22%	24%
Orange	32%	26%	21%	25%	26%
Purple	25%	23%	25%	23%	22%

Table 5:- Contrast value at 90%

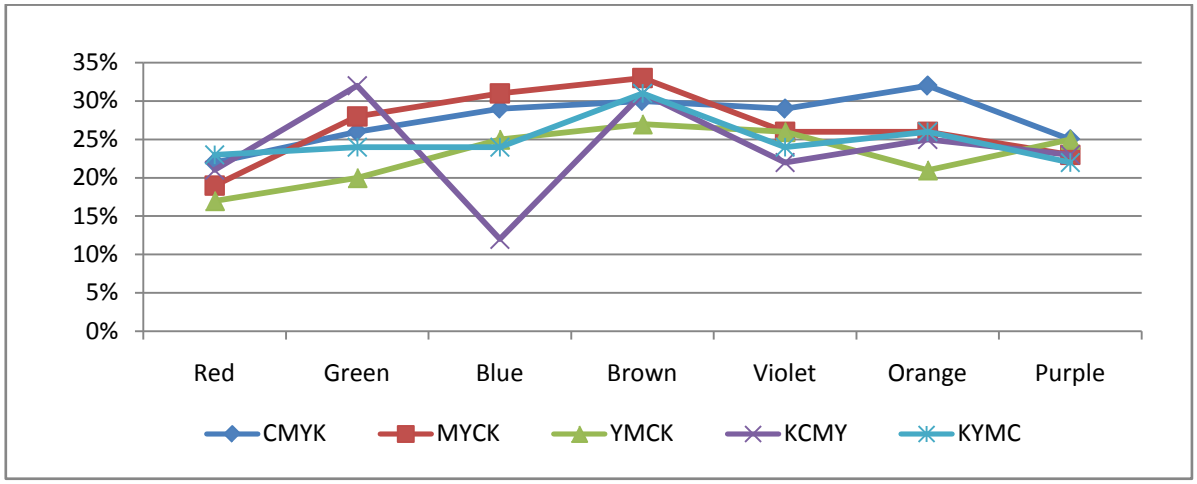

Figure 5: Contrast at 90%

The result observed in table 1 and figure 1 expressed that: -

- The highest contrast value of 'Brown' in the sequence MYCK, contrast value of 'Green' and 'Orange' was found higher in KCMY and CMYK respectively.
- The contrast value of 'Blue' in KCMY sequence was lowest.
- In all the sequences the contrast value of 'Purple' color was observed least variations.

Maplitho 70 GSM: Contrast value at 70%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	49%	45%	47%	44%	52%
Green	46%	51%	46%	52%	46%
Blue	50%	49%	44%	31%	44%
Brown	52%	49%	50%	48%	45%
Violet	49%	48%	45%	45%	42%
Orange	50%	51%	45%	38%	48%
Purple	50%	49%	49%	44%	41%

Table 6:- Contrast value at 70%

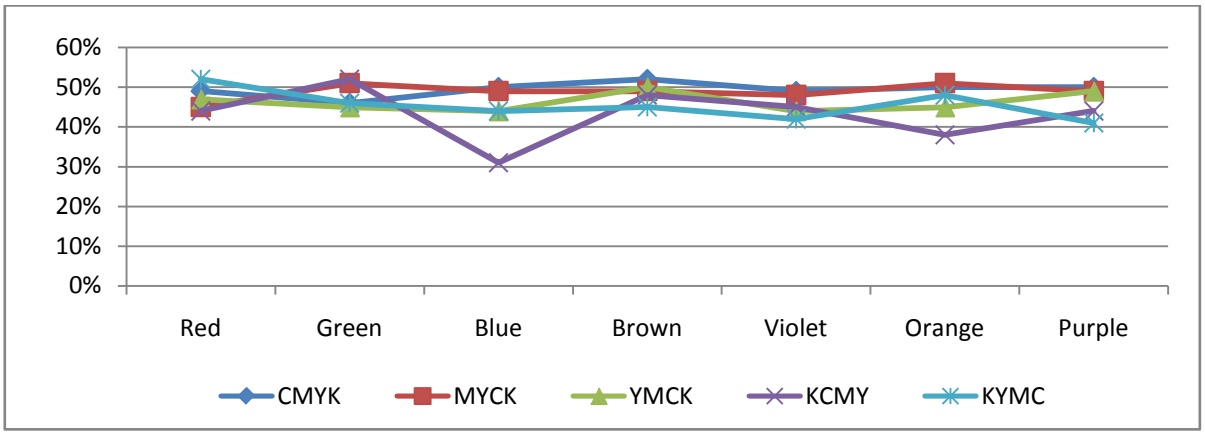

Figure 6: Contrast at 70%

The data expressed in table 6 and figure 6 depicted that: -

- The contrast value of 'Brown' in the sequence CMYK, YMCK was higher. In case of 'Green' and 'Red' color the maximum contrast was observed for KCMY and KYMC respectively.

- The contrast value of 'Blue' in the sequence KCMY is lowest.
- The least contrast value variation observed was in of 'Brown'& 'Violet' color.

Maplitho 70 GSM: Contrast value at 40%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	69%	66%	65%	69%	69%
Green	66%	70%	64%	73%	68%
Blue	70%	69%	65%	59%	65%
Brown	73%	73%	69%	73%	69%
Violet	74%	70%	69%	71%	64%
Orange	68%	68%	32%	64%	68%
Purple	67%	66%	67%	66%	62%

Table 7:- Contrast value at 40%

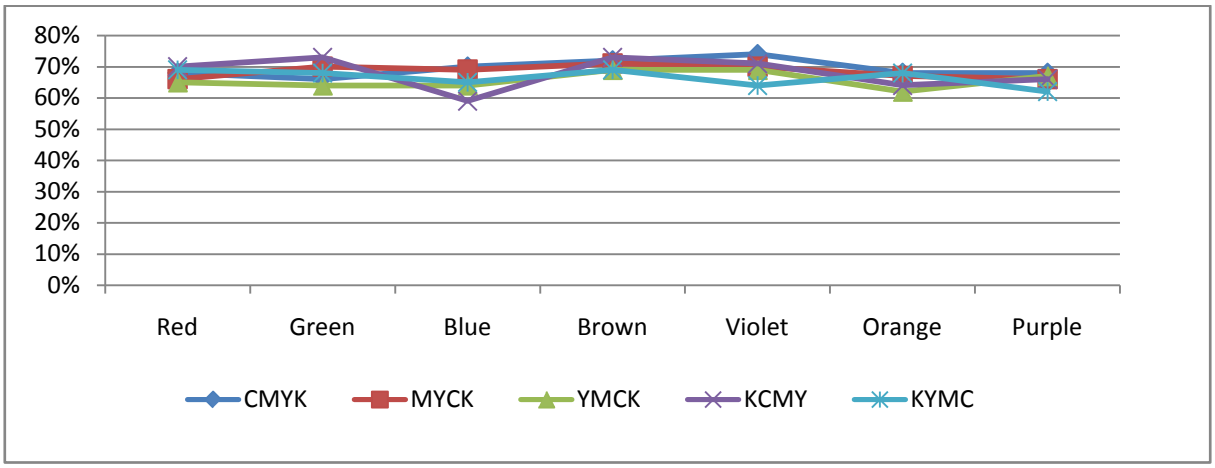

Figure 7: Contrast at 40%

The result presented in figure 7 and table 7 depicted that: -

- Among all the printing color sequences 'Violet' color contrast was observed in maximum range for CMYK series and 'Green' for KCMY sequence. On the other hand 'Blue' color contrast for KCMY sequence was observed minimum comparatively to other colors.
- The least variation was observed in the contrast of 'Purple' and 'Brown' color in all sequences.

Maplitho 70 GSM: Contrast value at 15%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	82%	80%	81%	83%	81%
Green	81%	84%	80%	87%	81%
Blue	81%	82%	78%	79%	78%
Brown	82%	82%	82%	86%	81%
Violet	83%	81%	79%	84%	78%
Orange	82%	83%	80%	82%	84%
Purple	84%	82%	84%	82%	79%

Table 8:- Contrast value at 15%

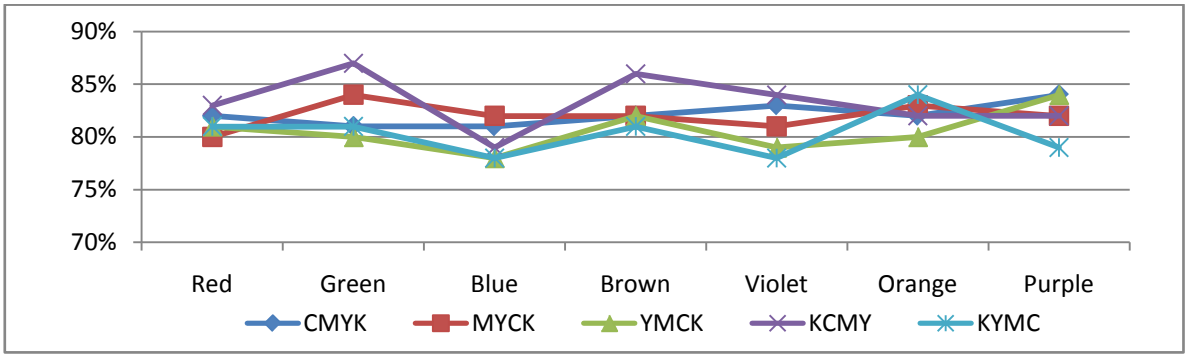

Figure 8: Contrast at 15%

The result of the observations of 15% contrast were presented in figure 8 and table 8 which depicted that in all different color sequences 'Green' color contrast was observed in maximum range for KCMY series. While minimum contrast was observed for 'Blue' color comparatively to other colors in YMCK series. Also among all sequences 'Orange' and 'Red' color exhibits least variation.

L*a*b* value

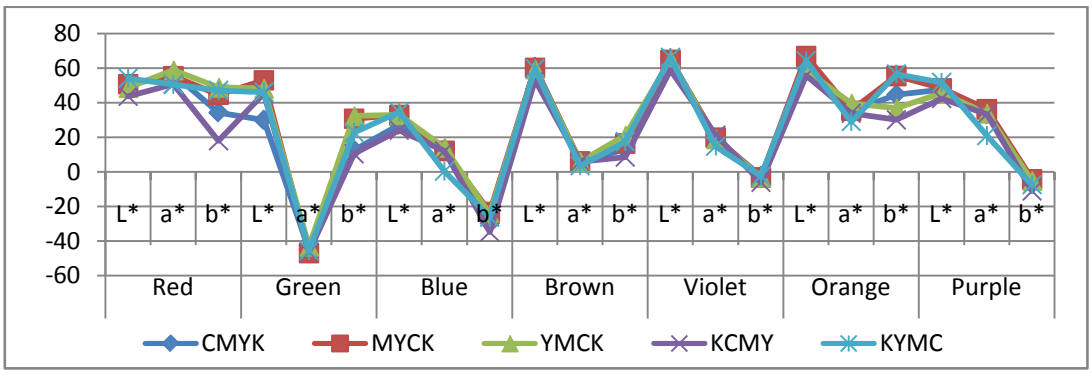

Figure 9: L*a*b* value

The result presented in figure 9 depicted that: -

- The least L*a*b* value was observed for 'Green' color in MYCK, KYMC and KCMY series.
- The maximum value was observed for 'Violet' color in KYMC, MYCK series.

IV. RESULTS AND DISCUSSION

After collecting the data, it was analyzed to conclude. It was observed that the results obtained during the research were in accordance with the standard range of print quality. During this research work the value of ink density, contrast and L*a*b* values were analysed in different ink sequences namely CMYK, MYCK, YMCK, KCMY and KYMC. This is summarized as follow:-

Ink Density: The ink density was observed at 90%, 70%, 40% and 15%. While research it was found that, among five color sequences, in YMCK & MYCK series 'Red' and 'Violet' color were observed for the maximum and minimum values of ink density respectively. The density value of Brown color was almost same in all sequence in case of 90% ink density. While the least variation was observed in the density of Brown color in all sequences when ink density at 70% was measured. At 40% ink density the least variation was observed in the density of Violet color in all sequences. Also among all sequences 'Blue' color exhibits least variation at density value 15%.

Contrast: When contrast was 90%, the highest contrast value of 'Brown' in the sequence MYCK. The contrast value of 'Brown' in the sequence CMYK, YMCK was higher at 70% contrast. Violet' color contrast was observed in maximum range for CMYK series and 'Green' for KCMY sequence at 40% contrast. At 15% contrast, Green' color contrast was observed in maximum range for KCMY series. In all the sequences the contrast value of 'Purple' color was observed least variations when contrast was 90%. But in case of 70%, the least contrast value variation observed was in of 'Brown'& 'Violet' color. While observing contrast value at 40%, the least variation was observed in the contrast of 'Purple' and 'Brown' color in all sequences. Also among all sequences 'Orange' and 'Red' color exhibits least variation at 15% contrast.

L*a*b* value: According to the value of L*a*b* value, the least value was observed for 'Green' color in MYCK, KYMC and KCMY series. The maximum value was observed for 'Violet' color in KYMC, MYCK series.

V. CONCLUSION

This research paper has presented a concise overview of effect of ink sequence on print quality in sheet-fed printing on Maplitho paper (70 gsm) with the reference parameters of print quality like Ink Density, Contrast and L*a*b* value or ΔE value. The basic research interest of this paper is to elucidate how different print color sequences respond to different print quality parameters. Among the five color sequences tasted, no one was better comparatively to another in all respects. Also one objective of this research paper was to analyze the differences in the ink density, contrast and ΔE value. While comparing print sequences YMCK series was found best suitable with reference to the color density. From contrast point of view CMYK & MYCK are best among five sequences. Print ink sequence MYCK, KYMC and KCMY series was most suitable for Green color.

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