International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 11, November 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

EFFECT OF WEAVE PATTERN AND PICKS DENSITY ON WOVEN FABRIC COLORMITERY

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ABSTRACT

This paper investigated the colomitery of woven fabrics according two independent variables; weave structure, and weft density. The selected weaves were represented as popular patterns used in Egyptian upholstery designs. Empirical results were analyzed statically, the component of colormitery values were affected by the number of additive marks and their direction concerned to twill and satin patterns, The differences between means of basket or plain weaves and other weaves were highly significant.. The component of colormitery values were influenced by the picks density therefore the warp floats rates. The participation percentage ratios of independent variables in colormitery components were concluded.

Keywords: ***Colormitery, L* A* B*, Picks density, Upholstery fabric, Weave pattern***

I. INTRODUCTION

Colorimetry is the science of defining and measuring colors in a way that will correlate to how an "average" person will see the color. Defining and measuring colors is difficult since each and every person sees color a little differently. Even though we each perceive colors slightly differently, the CIE has devised a standardized technique for defining and measuring colors using the data for a standard observer. The colorimetry enhanced efficiency and quality in textile manufacturing fields where corresponding design processing with technical requirement. However, no commercial system is available for accurate color imaging of Jacquard weave designs without first making the structural color effect in prototype form.[1]

Most attempts to explain the effect of structural parametric of woven fabric, Weft density and weave pattern on color difference were applied to polymeric fabrics. [2] [3]

A basic theory [4] [5] was used in this field to predict the color values on woven fabric surfaces according the color values of the geometric structure component then the deviation of calculated color values were compared with experimental measurements, this method was experimented for the fabrics composed from only single colored yarns.

The previous predictions were modified by considering the weave pattern, and color sequences on the fabric surface [6], The following model assumed that warp and weft yarns were uniform in the spacing and under intersection portions, actual results of color values were compared with both theoretical and simulated values. The framework continued showing detailed test method and results of this model were published. [7]

Modern CAD systems provide a variety of design tools that are supported by standardized color databases that allow simulation of weave structures on the computer monitor that could be printed on paper. However, deviations of the color values of these simulations still occur. Also, the color on fully flat fabric simulations on

paper or computer screen is two dimensional that differs from the real three-dimensional nature of fabrics and yarns. [8]

The target of the current paper to experimentally estimate the effect of the most practical weaves used for Egyptian jacquard upholstery woven by cotton yarns to help textile designers for imagining how to apply the weaves to close the final product to their art .

II. MATERIAL AND EXPERIMENTAL METHODS

2.1 Materials

Twenty six experimental samples were woven according two independent factors, weave type and picks density. Jacquard loom with 6144 hooks (5800 hooks for jacquard design), width=161 cm, speed= 400 picks/min, was used to weave the experimental fabrics as following:

- Warp specifications: cotton yarns, 50/2, 36 threads/cm.
- Picks specifications: cotton yarns, 40/2 , woven according two densities 30 picks/cm and 20 picks/cm
- weaves patterns: plain weave 1/1, basket weave, six satin weaves (16x16), and five twill weaves (16x16) as shown in figure (1).

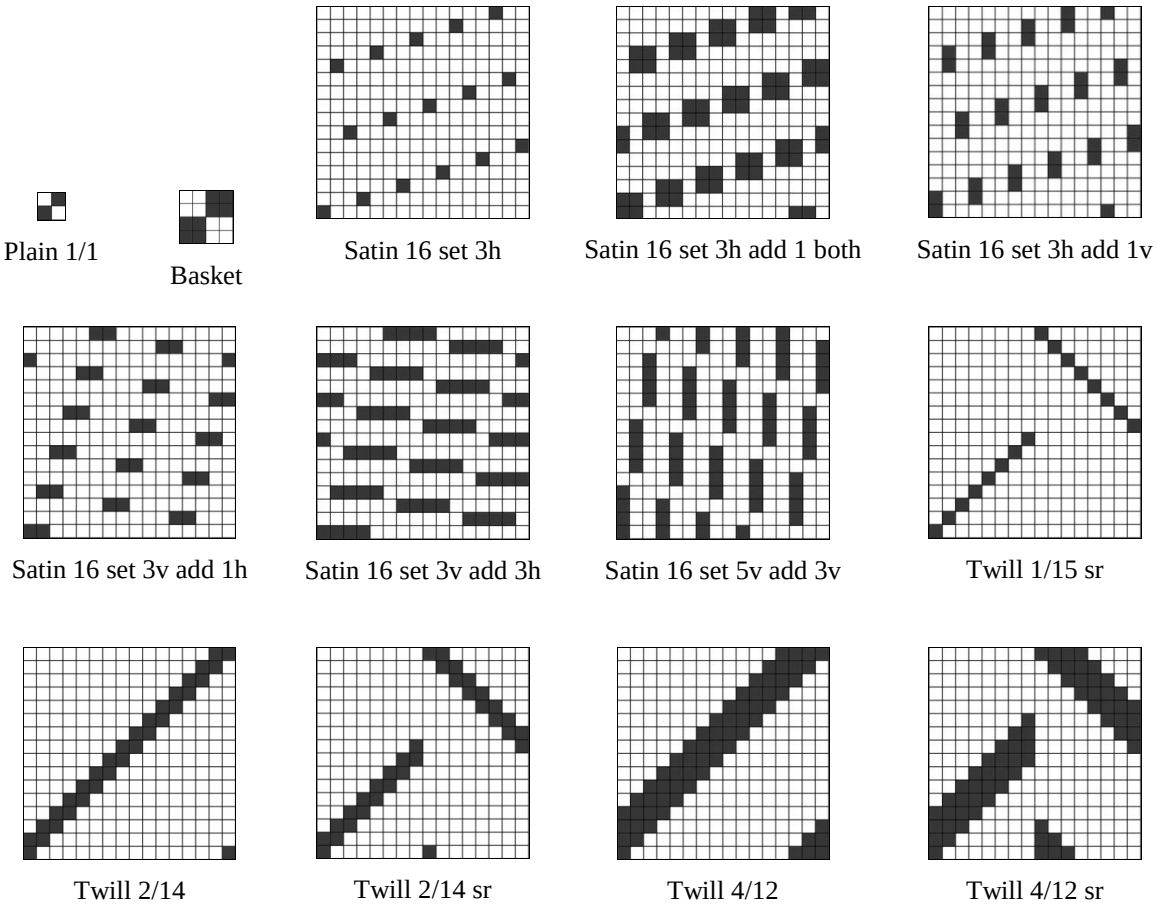

Figure (2) Weaves Patterns of Experimental Samples

2.2 Methods

The spectrophotometer Optimatch 3100 ® from the SDL Company was used for measuring the CIELAB parameters; lightness (L), red to green (a), and yellow to blue (b). All values of experimental samples woven by

30 and 20 picks/cm were compared with the two plain weave as standard specimen to conclude (ΔL), (Δa), (Δb), and colour quality tolerance (ΔE).

The (ΔE*ab) was calculated according the following equation [9]

$$\Delta E * ab = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2} \quad \text{……..“equation 1”}$$

The significant effects of independent parameter were estimated by two way analysis of variance. The stepwise regression was applied to predict colour values parameters and conclude the sharing percentage of independent factors to control the colour values.

III. RESULTS AND DISCUSSION

Table (1) showed values of lab colour system and ΔE of experimental samples in the day light, woven according difference in weaves structures and two picks densities.

Table 1. Lab and ΔE Values of Experimental Samples

Weave Structure	L		a		b		ΔE	
	20 picks	30 picks	20 picks	30 picks	20 picks	30 picks	20 picks	30 picks
plain 1/1	69.24	67.17	24.64	27.53	-7.75	-6.97	-	-
basket	71.2	67.63	23.2	27.85	-7.83	-6.8	2.433	0.586
satin16 set 3h	66.17	58.4	30.3	38.6	-6.6	-4.77	6.541	14.293
satin16 set 3h add 1 both	62.44	54.97	35.4	45.62	-7.03	-3.55	12.749	22.086
satin16 set 3h add 1v	58.79	53.58	38.96	46.8	-6.26	-2.46	17.790	24.008
satin16 set 3v add 1h	65.83	58.19	31.11	41.65	-7.28	-4.52	7.329	16.912
satin16 set 3v add 3h	62.41	57.6	33.88	38.71	-6.58	-4.46	11.550	14.929
satin16 set 5v add 3v	59.7	52.97	36.65	49.41	-6.78	-2.29	15.369	26.501
twill 1/15 sr	60.09	54.13	38.47	47.23	-6.25	-3.17	16.651	23.928
twill 2/14	61.63	54.41	36.85	46.59	-7.02	-3.57	14.406	23.188
twill 2/14 sr	60.3	54.18	38.94	47.16	-5.87	-3.48	16.969	23.796
twill 4/12	63.45	59.85	33.86	37.97	-7.6	-4.06	10.888	13.078
twill 4/12 sr	63.68	59.58	33.02	38.81	-6.91	-5.34	10.092	13.693

3.1 Effect of Weave Structure and Picks Density on Lightness Differece

Figure (2) showed chart of changing in lightness difference rates (ΔL) of experimental samples from the standard experimental sample (woven by plain weave), analysis of variance demonstrated that ΔL were highly significant influenced by the weaves of experimental samples.

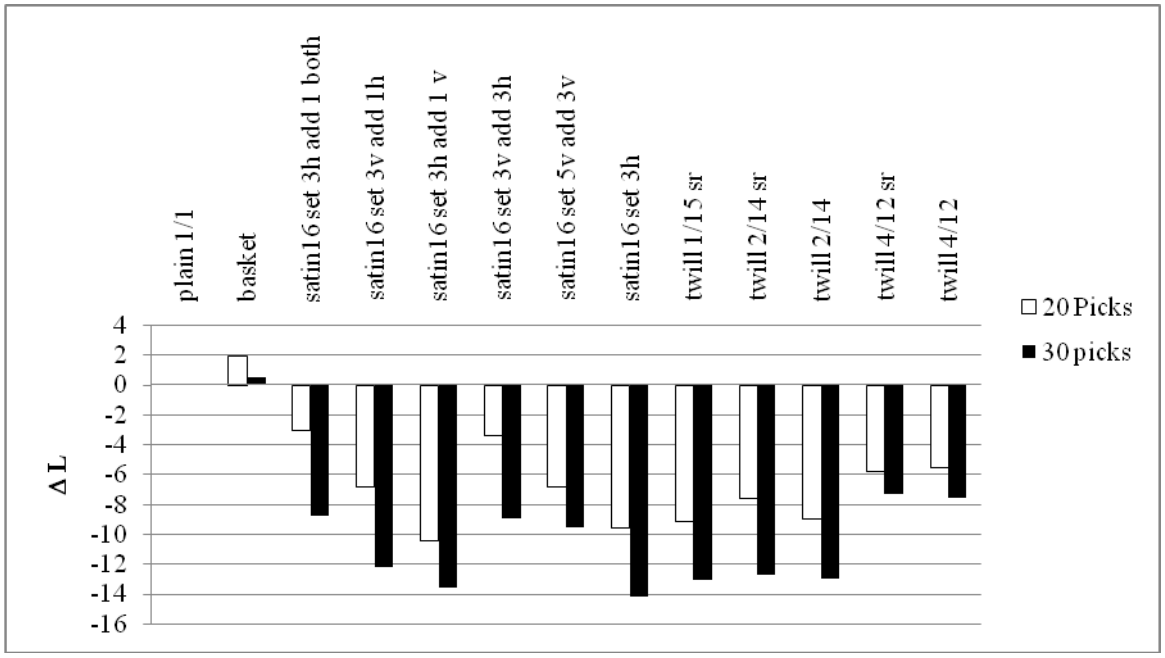

Figure (2) ΔL Values Chart of Experimental Samples

- Table (2) showed the mean difference of ΔL between the weaves and their significant.

All ΔL values in case of twill and satin weaves were negative due to decreasing their lightness values rates as they were weft weave structure.

ΔL value in case of basket weave had a positive trend; this trend was higher for lower picks density (20 picks/cm) where warp threads became more dominator.

The differences between means of basket or plain weaves and other weaves were highly significant.

Two factors influenced on the ΔL values in case of satin weaves or twill weaves; the number of additive marks and their direction. Adding one mark on both directions or three marks horizontally of satin 16 leaded to significant effects on ΔL, due to influencing collecting warp threads on the lightness value more than extended floats.

Adding three marks vertically of satin 16 significantly affected on differences of ΔL with satin 16 or satin 16 after adding one mark vertically.

Twill weave 4/12 and 4/12 reverse had significant differences in ΔL with all weaves with one or two additive marks.

The theoretical calculation of yarns diameters and spaces between them, according to pierce modeling were applied on experimental samples and displayed in table (3).

The adding of warp marks horizontally means that intersections with warp colours (white) groups in shorter spaces where spaces between warp threads (0.0963 mm) than ones repeated vertically; where spaces between either two picks density (0.1305 or 0.2972 mm) so the lightness was concentrated by horizontal repeating of warp intersections marks.

Table 2. ΔL Mean Significant Differences of Weaves

(I) weave	(J) weave	Mean Difference (I-J)
basket	plain 1/1	1.210
	satin16 set 3h	13.080(*)
	satin16 set 3h add 1 both	7.130(*)
	satin16 set 3h add 1 v	13.230(*)
	satin16 set 3v add 1h	10.710(*)
	satin16 set 3v add 3h	7.405(*)
	satin16 set 5v add 3v	9.410(*)
	twill 1/15 sr	12.305(*)
	twill 2/14	12.175(*)
	twill 2/14 sr	11.395(*)
	twill 4/12	7.785(*)
	twill 4/12 sr	7.855(*)
plain 1/1	satin16 set 3h	11.870(*)
	satin16 set 3h add 1 both	5.920(*)
	satin16 set 3h add 1 v	12.020(*)
	satin16 set 3v add 1h	9.500(*)
	satin16 set 3v add 3h	6.195(*)
	satin16 set 5v add 3v	8.200(*)
	twill 1/15 sr	11.095(*)
	twill 2/14	10.965(*)
	twill 2/14 sr	10.185(*)
	twill 4/12	6.575(*)
	twill 4/12 sr	6.645(*)
satin16 set 3h	satin16 set 3h add 1 both	-5.950(*)
	satin16 set 3h add 1 v	.150
	satin16 set 3v add 1h	-2.370
	satin16 set 3v add 3h	-5.675(*)
	satin16 set 5v add 3v	-3.670(*)
	twill 1/15 sr	-.775
	twill 2/14	-.905
	twill 2/14 sr	-1.685
	twill 4/12	-5.295(*)
	twill 4/12 sr	-5.225(*)

satin16 set 3h add 1 both	satin16 set 3h add 1 v	6.100(*)
	satin16 set 3v add 1h	3.580(*)
	satin16 set 3v add 3h	.275
	satin16 set 5v add 3v	2.280
	twill 1/15 sr	5.175(*)
	twill 2/14	5.045(*)
	twill 2/14 sr	4.265(*)
	twill 4/12	.655
	twill 4/12 sr	.725
satin16 set 3h add 1 v	satin16 set 3v add 1h	-2.520
	satin16 set 3v add 3h	-5.825(*)
	satin16 set 5v add 3v	-3.820(*)
	twill 1/15 sr	-.925
	twill 2/14	-1.055
	twill 2/14 sr	-1.835
	twill 4/12	-5.445(*)
	twill 4/12 sr	-5.375(*)
satin16 set 3v add 1h	satin16 set 3v add 3h	-3.305(*)
	satin16 set 5v add 3v	-1.300
	twill 1/15 sr	1.595
	twill 2/14	1.465
	twill 2/14 sr	.685
	twill 4/12	-2.925(*)
	twill 4/12 sr	-2.855(*)
satin16 set 3v add 3h	satin16 set 5v add 3v	2.005
	twill 1/15 sr	4.900(*)
	twill 2/14	4.770(*)
	twill 2/14 sr	3.990(*)
	twill 4/12	.380
	twill 4/12 sr	.450
satin16 set 5v add 3v	twill 1/15 sr	2.895(*)
	twill 2/14	2.765
	twill 2/14 sr	1.985
	twill 4/12	-1.625
	twill 4/12 sr	-1.555
twill 1/15 sr	twill 2/14	-.130
	twill 2/14 sr	-.910

	twill 4/12	-4.520(*)
	twill 4/12 sr	-4.450(*)
twill 2/14	twill 2/14 sr	-.780
	twill 4/12	-4.390(*)
	twill 4/12 sr	-4.320(*)
twill 2/14 sr	twill 4/12	-3.610(*)
	twill 4/12 sr	-3.540(*)
twill 4/12	twill 4/12 sr	.070

* *The mean difference is significant at the .05 level.*

The previous explanation agrees with Dimitrovski [10] who interpreted that different arrangement and agglomeration of interlacing points influence in different way on colour values of surfaces. Results showed increasing values of Lightness L*, this could be due to increase of the colour repeat surface (threads agglomeration).

Table 3. Theoretical calculation of fabric construction parameters

parameter	warp	picks	
	36 thread/cm	30 yarn/cm	20 yarn/cm
d_{mm}	0. 1814	0.2028	
p_{mm}	0.2777	0.3333	0.5
s_{mm}	0.0963	0.1305	0.2972

d_{mm}= yarn diameter in millimeter, p_{mm}= Space bettween to adjactant yarns in millimeter, p_{mm}= spaces between yarns in millimeter

- Analysis of variance referred that the picks density significantly effect on ΔL, Table (4) showed the mean difference between the two picks density and their significant. The increasing in ΔL value was influenced by decreasing in picks density; increasing of 20 picks experimental samples compared with 30 picks due to decreasing of picks covering so the white warp threads obviously appeared where increasing float length of warp thread and the lightness value increased. Also the lightness was influenced by how the nature of destination surface, this could be observed by more interlacing points per surface unit of fabric by increasing the weft density, which was caused the higher diffusion of light from the fabric surface. [2]

Table4. ΔL Mean Significant Differences of Picks

(I) picks	(J) picks	Mean Difference (I-J)
20	30	3.475(*)

- Stepwise regression referred that 92.7% of ΔL values could be controlled by the warp fraction of weave structure and picks density together, the increasing in warp fraction of weave structure shared 77.8% of the increasing in ΔL while the decreasing in picks density shared 14.9% of the increasing in ΔL.

Interpretation of ΔL was concluded from the following equation:

$Y = -5.219 + 28.812x_1 - 0.348x_2$ ……..*"equation 2"*

Where x_1 = warp fraction of weave, and x_2 = picks density, and y= ΔL

3.2 Effect of Weave Structure and Picks Density on Δa

Figure (3) showed chart of changing in Δa of experimental samples from the standard experimental sample (woven by plain weave), analysis of variance demonstrated that Δa were highly significant influenced by the weaves of experimental samples.

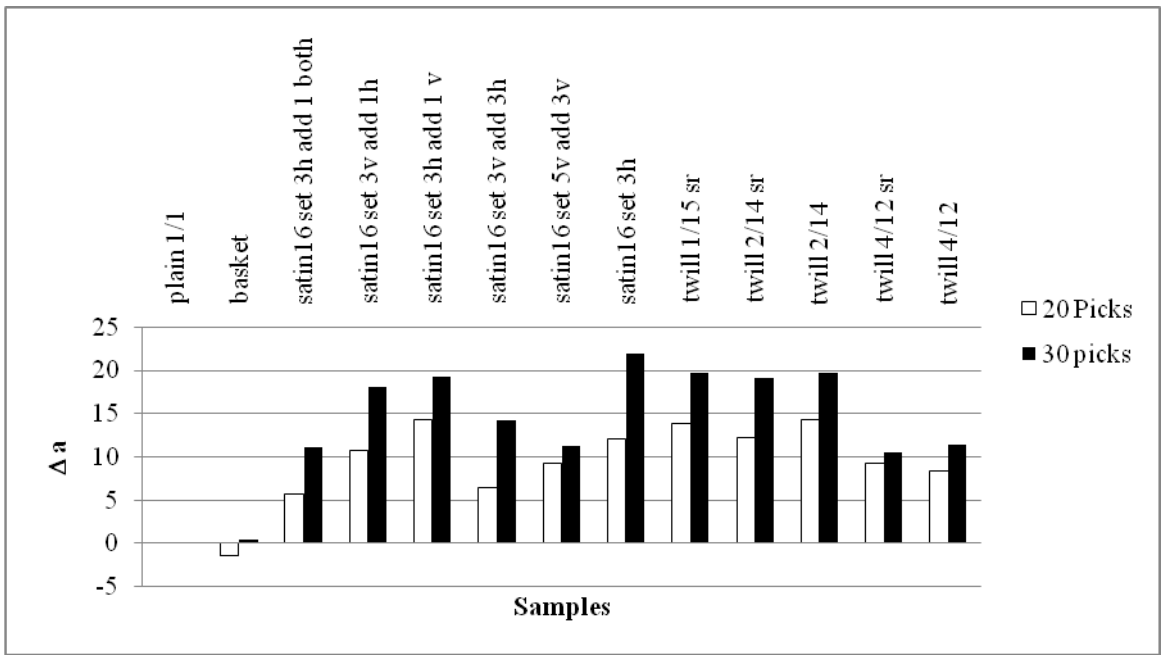

Figure (3) Δa Values Chart of Experimental Samples

- Table (5) showed the mean difference of Δa between the weaves and their significant.

All Δa values in case of twill and satin weaves were positive due to increasing their Δa values rates as they were weft weave structure where the float length of picks were greater so they preserved their original a values (before weaving).

Δa value in case of basket weave was insignificant due to neutral appearance of picks used for plain and basket weaves.

The differences between means of basket or plain weaves and other weaves were negative and highly significant.

Weave structures satin 16 and twill 1/15 had the highest Δa value; these values caused significant differences from weaves with four warp marks. The Δa values trended to increase according vertical addition of warp marks more than horizontal addition of the same number of the warp marks; the picks floats preserved their colour values.

- Analysis of variance referred that the picks density significantly effect on Δa, Table (6) showed the mean difference between the two picks density and their significant. The increasing in Δa value was influenced by

increasing in picks density; increasing of 30 picks experimental samples compared with 20 picks due to increasing of picks covering and support the positive portion of red green axis.

- Stepwise regression referred that 93.1% of Δa values could be controlled by the warp fraction of weave structure and picks density together, the decreasing in warp fraction of weave structure shared 79.6% of the increasing in Δa while the increasing in picks density shared 13.5% of the increasing in Δa .

Interpretation of Δa was concluded from the following equation:

$Y= 20.362 -41.462x_1 +0.47x_2$ ……..*"equation 3"*

Where x_1 = warp fraction of weave, and x_2 = picks density, and y= Δa

Table 5. Δa Mean Significant Differences of Weaves

(I) weave	(J) weave	Mean Difference (I-J)
basket	plain 1/1	-.560
	satin16 set 3h	-17.505(*)
	satin16 set 3h add 1 both	-8.925(*)
	satin16 set 3h add 1 v	-17.355(*)
	satin16 set 3v add 1h	-14.985(*)
	satin16 set 3v add 3h	-10.855(*)
	satin16 set 5v add 3v	-10.770(*)
	twill 1/15 sr	-17.325(*)
	twill 2/14	-17.525(*)
	twill 2/14 sr	-16.195(*)
	twill 4/12	-10.390(*)
	twill 4/12 sr	-10.390(*)
plain 1/1	satin16 set 3h	-16.945(*)
	satin16 set 3h add 1 both	-8.365(*)
	satin16 set 3h add 1 v	-16.795(*)
	satin16 set 3v add 1h	-14.425(*)
	satin16 set 3v add 3h	-10.295(*)
	satin16 set 5v add 3v	-10.210(*)
	twill 1/15 sr	-16.765(*)
	twill 2/14	-16.965(*)
	twill 2/14 sr	-15.635(*)
	twill 4/12	-9.830(*)
	twill 4/12 sr	-9.830(*)
satin16 set 3h	satin16 set 3h add 1 both	8.580(*)

	satin16 set 3h add 1 v	.150
	satin16 set 3v add 1h	2.520
	satin16 set 3v add 3h	6.650(*)
	satin16 set 5v add 3v	6.735(*)
	twill 1/15 sr	.180
	twill 2/14	-.020
	twill 2/14 sr	1.310
	twill 4/12	7.115(*)
	twill 4/12 sr	7.115(*)
satin16 set 3h add 1 both	satin16 set 3h add 1 v	-8.430(*)
	satin16 set 3v add 1h	-6.060(*)
	satin16 set 3v add 3h	-1.930
	satin16 set 5v add 3v	-1.845
	twill 1/15 sr	-8.400(*)
	twill 2/14	-8.600(*)
	twill 2/14 sr	-7.270(*)
	twill 4/12	-1.465
	twill 4/12 sr	-1.465
satin16 set 3h add 1 v	satin16 set 3v add 1h	2.370
	satin16 set 3v add 3h	6.500(*)
	satin16 set 5v add 3v	6.585(*)
	twill 1/15 sr	.030
	twill 2/14	-.170
	twill 2/14 sr	1.160
	twill 4/12	6.965(*)
	twill 4/12 sr	6.965(*)
satin16 set 3v add 1h	satin16 set 3v add 3h	4.130
	satin16 set 5v add 3v	4.215
	twill 1/15 sr	-2.340
	twill 2/14	-2.540
	twill 2/14 sr	-1.210
	twill 4/12	4.595(*)
	twill 4/12 sr	4.595(*)
satin16 set 3v add 3h	satin16 set 5v add 3v	.085
	twill 1/15 sr	-6.470(*)
	twill 2/14	-6.670(*)
	twill 2/14 sr	-5.340(*)

	twill 4/12	.465
	twill 4/12 sr	.465
satin16 set 5v add 3v	twill 1/15 sr	-6.555(*)
	twill 2/14	-6.755(*)
	twill 2/14 sr	-5.425(*)
	twill 4/12	.380
	twill 4/12 sr	.380
twill 1/15 sr	twill 2/14	-.200
	twill 2/14 sr	1.130
	twill 4/12	6.935(*)
	twill 4/12 sr	6.935(*)
twill 2/14	twill 2/14 sr	1.330
	twill 4/12	7.135(*)
	twill 4/12 sr	7.135(*)
twill 2/14 sr	twill 4/12	5.805(*)
	twill 4/12 sr	5.805(*)
twill 4/12	twill 4/12 sr	.000

* *The mean difference is significant at the .05 level.*

Table 6. Δa Mean Significant Differences of Picks

(I) picks	(J) picks	Mean Difference (I-J)
20	30	-4.698(*)

3.3 Effect of Weave Structure and Picks Density on Δb

Figure (4) showed chart of changing in Δb of experimental samples from the standard experimental sample (woven by plain weave), analysis of variance demonstrated that Δb were highly significant influenced by the weaves of experimental samples.

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 11, November 2015
www.ijarse.com
IJARSE
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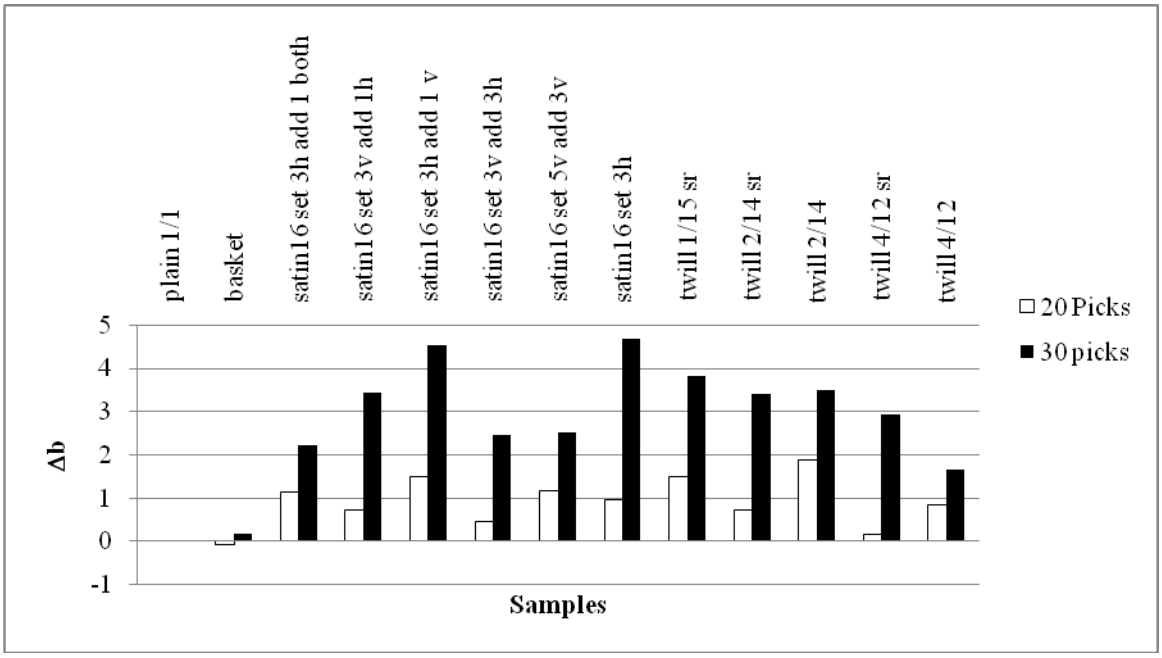

Figure (4) Δb Values Chart of Experimental Samples

- Table (7) showed the mean difference of Δb between the weaves and their significant. All b values showed in table (1) laid in the beginning of negative portion due to the nature of color content of pink picks where increasing of picks domination leaded to decreasing of negativity' this explanation maybe proved by the significant mean difference showed in table (8) where the increased coverage of picks overcome warp colour effects. The insignificant difference between weaves excluded plain and basket weaves due to relatively negativity of white warp b value, this meant to pull down and close the total b value of the fabric.

- Stepwise regression referred that 81.8% of Δb values could be controlled by the warp fraction of weave structure and picks density together, the decreasing in warp fraction of weave structure shared 38.6% of the increasing in Δa while the increasing in picks density shared 43.2% of the increasing in Δb.

Interpretation of Δb was concluded from the following equation:

$Y= -1.463 -6.385x_1 +0.186x_2$ ……..*"equation 4"*

Where x_1 = warp fraction of weave, and x_2 = picks density, and y= Δb

Table 7. Δb Mean Significant Differences of Weaves

(I) weave	(J) weave	Mean Difference (I-J)
basket	plain 1/1	.045
	satin16 set 3h	-2.780(*)
	satin16 set 3h add 1 both	-1.630
	satin16 set 3h add 1 v	-2.955(*)
	satin16 set 3v add 1h	-2.025(*)
	satin16 set 3v add 3h	-1.415
	satin16 set 5v add 3v	-1.795(*)
	twill 1/15 sr	-2.605(*)
	twill 2/14	-2.640(*)
	twill 2/14 sr	-2.020(*)
	twill 4/12	-1.190
	twill 4/12 sr	-1.485
plain 1/1	satin16 set 3h	-2.825(*)
	satin16 set 3h add 1 both	-1.675
	satin16 set 3h add 1 v	-3.000(*)
	satin16 set 3v add 1h	-2.070(*)
	satin16 set 3v add 3h	-1.460
	satin16 set 5v add 3v	-1.840(*)
	twill 1/15 sr	-2.650(*)
	twill 2/14	-2.685(*)
	twill 2/14 sr	-2.065(*)
	twill 4/12	-1.235
	twill 4/12 sr	-1.530
satin16 set 3h	satin16 set 3h add 1 both	1.150
	satin16 set 3h add 1 v	-.175
	satin16 set 3v add 1h	.755
	satin16 set 3v add 3h	1.365
	satin16 set 5v add 3v	.985
	twill 1/15 sr	.175
	twill 2/14	.140
	twill 2/14 sr	.760
	twill 4/12	1.590
	twill 4/12 sr	1.295

satin16 set 3h add 1 both	satin16 set 3h add 1 v	-1.325
	satin16 set 3v add 1h	-.395
	satin16 set 3v add 3h	.215
	satin16 set 5v add 3v	-.165
	twill 1/15 sr	-.975
	twill 2/14	-1.010
	twill 2/14 sr	-.390
	twill 4/12	.440
	twill 4/12 sr	.145
satin16 set 3h add 1 v	satin16 set 3v add 1h	.930
	satin16 set 3v add 3h	1.540
	satin16 set 5v add 3v	1.160
	twill 1/15 sr	.350
	twill 2/14	.315
	twill 2/14 sr	.935
	twill 4/12	1.765(*)
	twill 4/12 sr	1.470
satin16 set 3v add 1h	satin16 set 3v add 3h	.610
	satin16 set 5v add 3v	.230
	twill 1/15 sr	-.580
	twill 2/14	-.615
	twill 2/14 sr	.005
	twill 4/12	.835
	twill 4/12 sr	.540
satin16 set 3v add 3h	satin16 set 5v add 3v	-.380
	twill 1/15 sr	-1.190
	twill 2/14	-1.225
	twill 2/14 sr	-.605
	twill 4/12	.225
	twill 4/12 sr	-.070
satin16 set 5v add 3v	twill 1/15 sr	-.810
	twill 2/14	-.845
	twill 2/14 sr	-.225
	twill 4/12	.605
	twill 4/12 sr	.310
twill 1/15 sr	twill 2/14	-.035
	twill 2/14 sr	.585

	twill 4/12	1.415
	twill 4/12 sr	1.120
twill 2/14	twill 2/14 sr	.620
	twill 4/12	1.450
	twill 4/12 sr	1.155
twill 2/14 sr	twill 4/12	.830
	twill 4/12 sr	.535
twill 4/12	twill 4/12 sr	-.295

* *The mean difference is significant at the .05 level.*

Table 8. Δb Mean Significant Differences of Picks

(I) picks	(J) picks	Mean Difference (I-J)
20	30	-1.86(*)

3.4 Effect of Weave Structure and Picks Density on ΔE

Figure (5) showed chart of changing in ΔE of experimental samples from the standard experimental sample (woven by plain weave), analysis of variance demonstrated that ΔE were highly significant influenced by the weaves of experimental samples.

- Table (9) showed the mean difference of ΔE between the weaves and their significant.

All ΔE of plain and basket were less than satin and twill weaves. All means differences between plain or basket and any satin or twill weave were significant and negative.

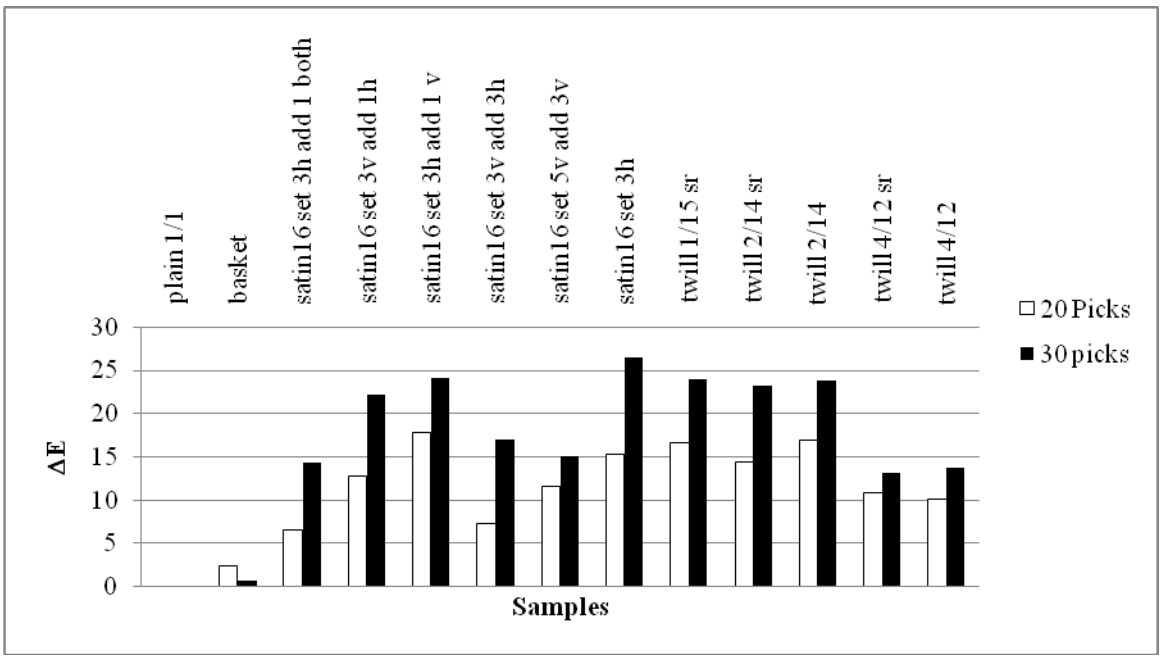

Figure (5) ΔE Values Chart of Experimental Samples

Two factors influenced on the ΔE values in case of satin weaves or twill weaves; the number of additive marks and their direction. Adding one mark on both directions or three marks horizontally of satin 16 leaded to significant effects on ΔE, due to influencing collecting warp threads on ΔE value more than extended floats.

Adding three marks vertically of satin 16 significantly affected on differences of ΔE with satin 16 or satin 16 after adding one mark vertically.

Twill weave 4/12 and 4/12 reverse had significant differences in ΔE with all weaves with one or two additive marks.

Table 9. ΔE Mean Significant Differences of Weaves

(I) weave	(J) weave	Mean Difference (I-J)
basket	plain 1/1	1.509
	satin16 set 3h	-19.425(*)
	satin16 set 3h add 1 both	-8.906(*)
	satin16 set 3h add 1 v	-19.389(*)
	satin16 set 3v add 1h	-15.908(*)
	satin16 set 3v add 3h	-10.613(*)
	satin16 set 5v add 3v	-11.950(*)
	twill 1/15 sr	-18.780(*)
	twill 2/14	-18.514(*)
	twill 2/14 sr	-17.287(*)
	twill 4/12	-10.383(*)
	twill 4/12 sr	-10.474(*)
plain 1/1	satin16 set 3h	-20.935(*)
	satin16 set 3h add 1 both	-10.415(*)
	satin16 set 3h add 1 v	-20.899(*)
	satin16 set 3v add 1h	-17.417(*)
	satin16 set 3v add 3h	-12.122(*)
	satin16 set 5v add 3v	-13.459(*)
	twill 1/15 sr	-20.290(*)
	twill 2/14	-20.024(*)
	twill 2/14 sr	-18.797(*)
	twill 4/12	-11.892(*)
	twill 4/12 sr	-11.983(*)
satin16 set 3h	satin16 set 3h add 1 both	10.520(*)
	satin16 set 3h add 1 v	.036
	satin16 set 3v add 1h	3.517

	satin16 set 3v add 3h	8.812(*)
	satin16 set 5v add 3v	7.475(*)
	twill 1/15 sr	.645
	twill 2/14	.911
	twill 2/14 sr	2.138
	twill 4/12	9.042(*)
	twill 4/12 sr	8.951(*)
satin16 set 3h add 1 both	satin16 set 3h add 1 v	-10.484(*)
	satin16 set 3v add 1h	-7.002(*)
	satin16 set 3v add 3h	-1.707
	satin16 set 5v add 3v	-3.044
	twill 1/15 sr	-9.875(*)
	twill 2/14	-9.609(*)
	twill 2/14 sr	-8.382(*)
	twill 4/12	-1.477
	twill 4/12 sr	-1.568
satin16 set 3h add 1 v	satin16 set 3v add 1h	3.481
	satin16 set 3v add 3h	8.776(*)
	satin16 set 5v add 3v	7.440(*)
	twill 1/15 sr	.609
	twill 2/14	.875
	twill 2/14 sr	2.102
	twill 4/12	9.006(*)
	twill 4/12 sr	8.915(*)
satin16 set 3v add 1h	satin16 set 3v add 3h	5.295
	satin16 set 5v add 3v	3.958
	twill 1/15 sr	-2.872
	twill 2/14	-2.606
	twill 2/14 sr	-1.379
	twill 4/12	5.525
	twill 4/12 sr	5.434
satin16 set 3v add 3h	satin16 set 5v add 3v	-1.337
	twill 1/15 sr	-8.167(*)
	twill 2/14	-7.901(*)
	twill 2/14 sr	-6.674(*)
	twill 4/12	.230
	twill 4/12 sr	.139

satin16 set 5v add 3v	twill 1/15 sr	-6.830(*)
	twill 2/14	-6.565(*)
	twill 2/14 sr	-5.338
	twill 4/12	1.567
	twill 4/12 sr	1.476
twill 1/15 sr	twill 2/14	.266
	twill 2/14 sr	1.493
	twill 4/12	8.397(*)
	twill 4/12 sr	8.306(*)
twill 2/14	twill 2/14 sr	1.227
	twill 4/12	8.131(*)
	twill 4/12 sr	8.040(*)
twill 2/14 sr	twill 4/12	6.904(*)
	twill 4/12 sr	6.813(*)
twill 4/12	twill 4/12 sr	-.091

** The mean difference is significant at the .05 level.*

- Analysis of variance referred that the picks density significantly effect on ΔE, Table (10) showed the mean difference between the two picks density and their significant. The increasing in ΔE value was influenced by increasing in picks density; increasing ΔE of 30 picks experimental samples compared with one of 20 picks due to increasing of picks domination due to increased picks covering .

Stepwise regression referred that 91.2% of ΔE values could be controlled by the warp fraction of weave structure and picks density together, the decreasing in warp fraction of weave structure shared 76.9% of the increasing in ΔE while the increasing in picks density shared 14.3% of the increasing in ΔE .

Interpretation of Δa was concluded from the following equation:

$Y= 10.18 -47.812x_1 +0.569x_2$ ……..*"equation 5"*

Where x_1 = warp fraction of weave, and x_2 = picks density, and y= ΔE

Table 10. ΔE Mean Significant Differences of Picks

(I) picks	(J) picks	Mean Difference (I-J)
20	30	-5.688(*)

IV. CONCLUSION

The weave structure and picks density significantly affected on colour values of woven fabrics. Two factors influenced on the ΔL values in case of satin weaves or twill weaves; the number of additive marks and their direction. Collecting warp threads horizontally influenced the lightness value more than their extended floats; the lightness was concentrated by horizontal repeating of warp intersections marks.

The increasing in ΔL value was influenced by decreasing in picks density due to decreasing of picks covering and increasing the warp floats. the lightness was influenced by how the nature of destination surface, this could be observed by more interlacing points per surface unit of fabric by increasing the weft density, which was caused the higher diffusion of light

Weave structures satin 16 and twill 1/15 had the highest Δa value, these values trended to increase according vertical addition of warp marks more than horizontal addition of the same number of the warp marks; the picks floats preserved their colour values.

The increasing in Δa value was influenced by increasing in picks density due to increasing of picks covering and support the positive portion of red green axis.

All b values laid in the beginning of negative portion due to the nature of color content of pink picks where increasing of picks domination leaded to decreasing of negativity; the increased coverage of picks overcome warp colour effects.

All ΔE of plain and basket were less than satin and twill weaves. All means differences between plain or basket and any satin or twill weave were significant and negative. Adding marks horizontally in satin 16 leaded to significant effects on ΔE, due to influencing collecting warp threads on ΔE value more than extended floats. Twill weave 4/12 and 4/12 reverse had significant differences in ΔE with all weaves with one or two additive marks.

Decreasing of warp fraction of weave structure participated more than five times increasing of picks density in increasing of ΔE.

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