EFFECT OF THE AVEARAGE WARP AND WEFT DENSITY ON C* ,H* AND L*OF DYED COTTON FABRICS

تأثير تغير متوسط تشييف خيوط السداء وكثافة خيوط اللحمة على درجة استضاءة اللون ونقاءه وهويته للأقمشة المصبوغة

A. M. EL-HOSSINI
TEXTILE DEPT. ,FACULTY OF ENG.

الخلاصة – يهدف هذا البحث الى دراسة تأثير تغيير متوسط تشييف خيوط السداء للتركيب النسجي السادة الممتد من السداء فقط ، كثافة اللحمه ، وتنوع الصبغات المستخدمة . نسجت أقمشة متعددة وتنوعت طبقا لمواصفات التشغيل والتجهيز من حيث :–

- . تغيير كثافة حدفات اللحمه فى وحدة القياس .
- . تثبيت كثافة خيوط السداء فى وحدة القياس .
- . خيوط السداء من قطن ١٠٠٪ .
- . حدفات اللحمه مخلوطة من بولى استر بنسبة ٦٥٪ قطن بنسبة ٣٥٪ .
- . تم صباغة كل من المنسوجات المنتجة بالصبغات الاتية :–

(أ) الصباغة المباشرة (ب) صباغة الأحواض (ج) الصباغة النشطة

بعد ذلك تم قياس بعض الخواص اللونية للأقمشة مثل :–
– درجة النقاء والاستضاءة للون ، وهويته – وأظهرت النتائج أنه بزيادة متوسط تشييف خيوط السداء يزداد نقاء اللون ، ويقل زاوية هويته كما يقل درجة استضاءته كما وجد أنه بازدياد كثافة الحدفات يزداد درجة استضاءة اللون وهويته ، ويقل درجة نقاء اللون .

ABSTRACT:

The effect of the avearage warp yarn float, weft yarn density and the type of dyes on, fabric colour properties was investigated. Five different avearage warp yarn floats, each of three different weft yarns density were woven then dyed with three different type dyes which are direct, vat, and reactive dyes.

A total of 45 different specimens each represents different case were tested to obtain psychrometric chroma (C), hue angle (H) and lightness (L), the results showed that both weft density and warp average float have a remarkable effect on fabric colour properties.

It was found that, in general, the increasing of the average float lead to decreases the hue angle (H) and the lightness (L) which give an increasing in psychrometric chrome. But the increasing of the weft yarn density lead to increasing in the hue angle (H) and lightness (L) which give a decreasing in the psychrometric chroma (C).

INTRODUCTION :

Colour and weave effects in the form of pattern, is produced by colour and weave in combination. It is frequently quite different in appearance from either the order of colouring or the weave, because:

i) The weave tends to break the continuity of the colours of warp and weft, and
ii) A colour shows on the face of the fabric, whether it is brought up in warp float or in weft float. (1)

From elements of colour is lustre, lustre and colour are two associated physical phenomena which demand particular attention from the textile designer due to their prominent influence on the appearance of woven fabrics.

When light falls on a fabric some of it may be reflected at the surface of the fibres, sometimes passing through one or more fibres before being so reflected, and some may be reflected by irregularities within the fibres, the former reflection may be more or less regular, as if form a mirror, and gives rise to lustre; the latter is diffuse, reducing lustre and, if the fabric is dyed, giving rise to colour.

The lustrous appearance of the fabric will depend upon (1):

(a) the characteristics of the fibre,
(b) the way in which the fibres are arranged in the yarn,
(c) the fabric construction and
(d) the finishing technique applied.

Smooth and uniform fibres e.g. nylon and silk, act like mirrors and give a very high lustre whilst irregular and twisted fibres, e.g cotton, give verey poor lustre (mercerised cotton is more lustrous because it is rounder in cross section than untreated cotton).

In common with the mechanism outlined in respect of fibres and yarns, a weave which presents large continuous area of yarn to view, e.g. a sateen, gives a higher luster than one where there are many thread interlacings, e.g. a plain weave or a crepe weave. Similarly, finishes which are designed to enhance the lustre increase the uniformity and the regularity of the cloth surface, e.g. Calendering, beetling, whilst techniques intended to destroy lustre, achieve their aim by disturbing the surface.

A body emits light when some electrons in it lose energy. (1,2). Energy can be given to the electrons in the form of light energy by heat the more energy the electron have and the greater energy lost by the electron, to the shorter the weave light of the weave emitted thus all bodies emit some visible light.

As will as emitting radiation, boding also absorb, when it absorb every thing which falls on them, its called black bodies, but others absorb only certain weave lights and reflect the rest of the radiations. (2)

COLOUR MEASUREMENT

The Perception of colour is a sensation. At the same time, colour measurement can only determine the physical properties of a dyeing. With the help of colorimetry, it is possible, however, to convert physical data in such a manner, so that statement concerning the perception of colour are possible. Empirical data determined by investigating the colour vision of a considerable number of people form the basis of colorimetry (3,4).

The radiation of the wavelengths between approximately 400 and 700 nm (1 nm = 1 um = 10 -9 m = 1 billionth of a meter) striking the retina of the eye is sensed as light or colour: The colours of the individual wavelength sectors are violet (400 - 430 nm), blue (430 - 485 nm), green (485 - 570 nm) yellow (570 - 585 nm), orange (585 - 610 nm) and red (above 610 nm).

The radiation of the light source falling on the viewed object is partly reflected by it, partly absorbed and partly transmitted. In colour measurement, it is usually assumed that the objects to be measured are opaque. In this case, only the reflected or, conversely, the absorbed portion of the radiation is of interest. The reflected portion is called reflectance is defined as the ratio of the light reflected by an object at a certain wavelength to the light reflected by an ideally white surface. The ideally white surface, which most be observed under the same conditions of illumination as the sample, reflects all the incident light diffusely into the semispace. Since spectral reflectance is the ratio of the light reflected at the same wavelength from sample and from a white standard, it is, for non fluorescing samples, independant of the spectral distribution of the light source which is used in the measurement.

In order to define the colour of an object, which is given by the spectral energy distribution E_λ R_λ , it is first necessary to determine the proportions of the three primary colours (yellow, blue, red) required to produce the colour of the object at a particular wavelength. There proportions are given by the three expressions

$$E_\lambda \; R_\lambda \; \bar{X}_\lambda \quad E_\lambda \; R_\lambda \; \bar{Y}_\lambda \quad E_\lambda \; R_\lambda \; \bar{Z}_\lambda$$

These expressions must now be determined for each reparate wave length and their sum obtained for all lengths of the visible range, corresponding to the following three integrations : (5)

$$X = \int_{400}^{700} R.\, E.\, \bar{x}$$

$$Y = \int_{400}^{700} R.\, E.\, \bar{y}$$

$$Z = \int_{400}^{700} R.\, E.\, \bar{z}$$

where $\bar{R}$ = reflectance % of sample at $\lambda_{400} - \lambda_{700}$

E = light source energy by microwall $\lambda_{400} - \lambda_{700}$

$\bar{X}$, $\bar{Y}$, $\bar{Z}$ = Extinction coefficients (sinsitivity) of human eye to the red, yellow and blue regious of the visible spectrum respectively at $\lambda_{400} - \lambda_{700}$.

A colour is thus defined by three numbers, X, Y, Z which are known as the tristimulus values. In other words X, Y, Z are thus the factors of the three virtual primary colours which by additive mixture give the standard observer the colour consation.

In order to define a colour diagramatically a dimensional representation known as a chromaticity diagram or colour chart was evaluated use the socalled chromaticity coordinates which are defined by the three following equations:

$$x = \frac{X}{x + y + z} \quad y = \frac{Y}{x + y + z} \quad z = \frac{Z}{x + y + z}$$

The sum of these coordinates is 1, so that only two values are required to define the type of colour or chromaticity.

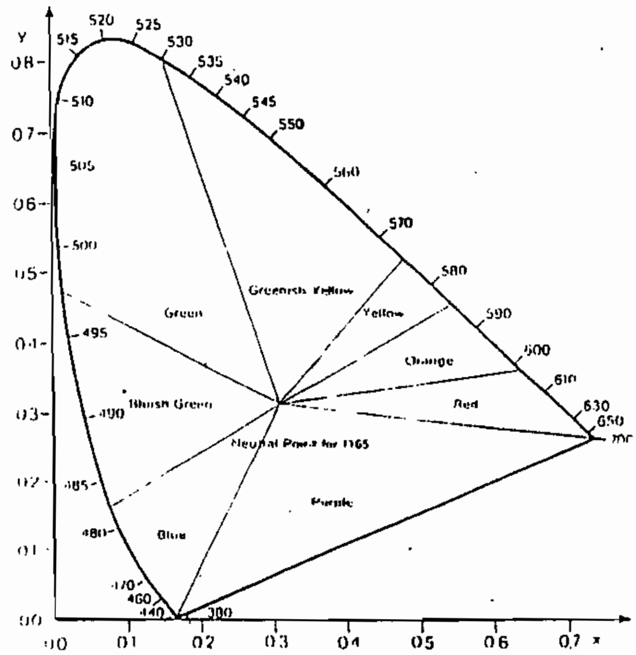


Fig.(3) represents the CIE chromacity diagram.

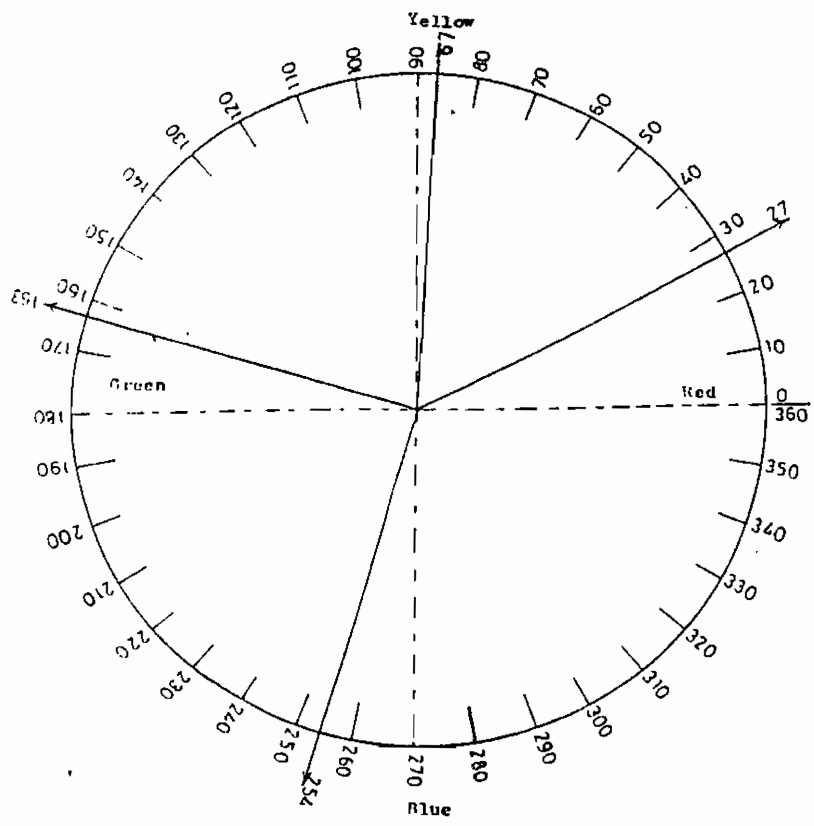


Fig. (4)

The chromaticily coordinates X and Y one plotted in the CIE Chromaticity Diagram Fig. (3) for graphical presentation. All realizable surface colours lie within the drawn curve, which represents the chromaticities of the spectral colours.

Approximately in the centre of the chromaticity diagram is the neutral point, which represents the chrcmationess of white, grey or black colours. Colours of equal hue lie on a line between the neutral point and the borderline of the diagram. Their saturation is indicated by the distance from the neutral point. The further the colour is located from the neutral point, the more saturated it is.

The dyed samples of the project were evaluated and measured colorimetrically by labscan instrument model 5100 (at El-Nasr dyeing & finishing Co. Mehalla El-Kobra).

Lightness (L), psychometric chroma (C), and hue angle (H) are abtometically measured according to the more advanced LCH system (5, 6, 7) drived from the prevlous tristimulus values as follows:

$$L^* = 116\,(Y/Y_0)^{1/3} - 16$$

$$C^*_{ab} = [\,(a)^2 + (b)^2\,]^{1/2}$$

$$H^* = \text{arc Tan } b/a$$

where $a = 500\,(\frac{X}{X_0})^{1/3} - (\frac{Y}{Y_0})^{1/3}$

and it represents the location or the intersection of the colour of the dyed sample on the red - green axis of the colour solid.

$$b = 200\,(\frac{Y}{Y_0})^{1/3} - (\frac{Z}{Z_0})^{1/3}$$

and it represents the location or the intersection of the colour on the yellow - blue axis of the colour solid.

L^* = degree of lightness of colour
C^* = psychometric chroma or saturation or purity of the colour
H^* = hue angle in opponent colour scale
X_0, Y_0, Z_0 equal to tristimulus values of absolute white scale according to CIE system where :
$X_0 = 98.04$, $Y_0 = 100$, $Z_0 = 118.103$

EXPERIMENTAL WORK:

The Material:-

Defferant fabric structures were used:
plain weave 1/1
warp rib weave 2/1
warp rib weave 3/1
warp rib weave 3/2
warp rib weave 3/3
as a grey cotton fabric having different no of ends each (19, 17, 15).

1- Scouring and Bleaching:-

All these fabrics were scoured and bleached in the same bath used the reagents:

caustic soda (as technical grade chemicals)
Hydrogin peroxide 50%
Sodium silicute.

Processes:
Combined scouring and bleaching were carried out using a solution containing 20 C.C / litre of caustic soda 38° Be., 35 C.C / liter hydrogen peroxide and 5 gm/liter sodium silicate.

The treatment was allowed to process for 60 min, at boil with agitation. The washing off was carried out in hot water (80°C) and cold water, then the fabric was dried.

II - Dyeing :

The bleached fabrics were dyed by exhaustion processes with differant classes of cotton dyes such as :

a) direct dyes
b) vat dyes
c) reactive dyes ; as followes :

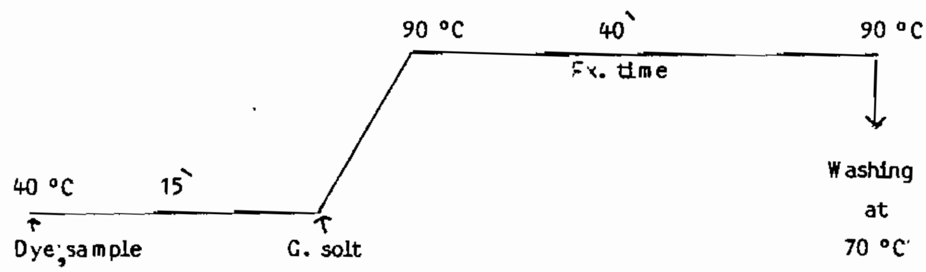
a - Dyeing With Direct Dyes:

Reagents :

Esma yellow RL (Esmadye)
G. salt (Na_2CO_3) 20 g/L .

Processes :

A 1% depth could be obtained by carring out the dyeing proceduse by the following exhaustion diagram.



The dyed sample was followed by warm washing then, cold wash and finally drying.

b. Dyeing with Vat Dye:

Reagents :

Ostamthrene yellow GC.

Sodium hydrosulphite ($Na_2 S_2 O_4$),
and sodium hydroxide (Na oH)

Type of Processes :
Exhausion process (I_N)

Processes :
A 1% depth could be obtained by carring out the dyeing proceduse by following exhaustion diagram

55 °C — 45` — 55 °C

↑ Dye + NaoH 13 CC / 1 + $Na_2 S_2 O_4$ 3.6 g/1 + sample

↓ Oxidation by $H_2 O_2$ 2 C.C / L

Oxidation was done after 4b minutes by $H_2 O_2$ (2 C.C / L, 50%), soaping by (5g/1) soap and (2g/l). Soda ash, then hot and cold rinsing, and finally drying.

(c) Dyeing with Reactive Dye:

Reagents :

Dye	(Levafix	yellow	E - 3.G)
G. solt ($Na_2 So_4$)			40 g/1
Alklie ($Na_2 Co_3$)			10 g/1

Processes :
A 1% depth could be obtained by carring out the dyeing proceduse by the following exhausion diagram.

40 °C — 10` — 10` — 30` — Fix 60` — 40 °C

↑ Dye + sample — ↑ 1/2 G. salt — ↑ 1/2 G.salt — ↑ Alkali — ↓ washing

The washing process was followed by cold wash, neutral soaping, rinsing with hot water, cold rinsing and finally, drying.

RESULTS AND DISCUSSION

Since the primary objective this work to get acquanted with the experimental techniques of the wet processing of cotton fabric as well to have a real handling of the fabric during the sequences of the various processes, experiments were designed to include the following.

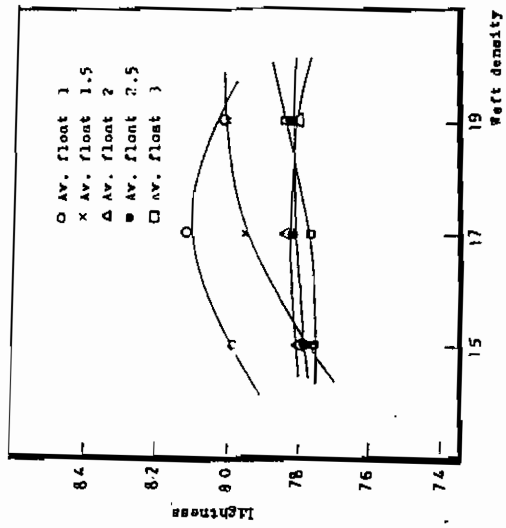


Fig. (10)
(Effect of weft density on lightness)

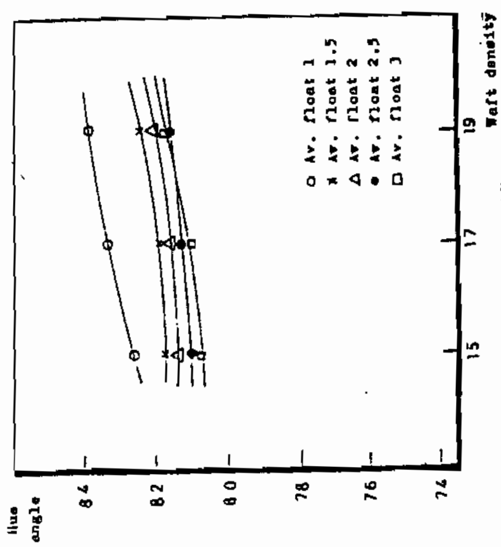


Fig. (9)
(Effect of weft density on hue angle)

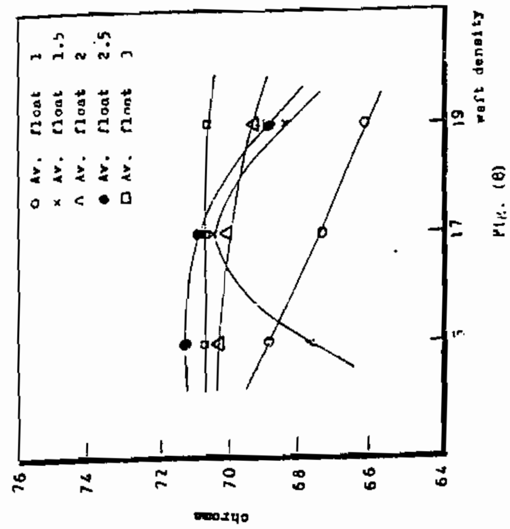


Fig. (8)
(Effect of weft density on psychromatic chroma)

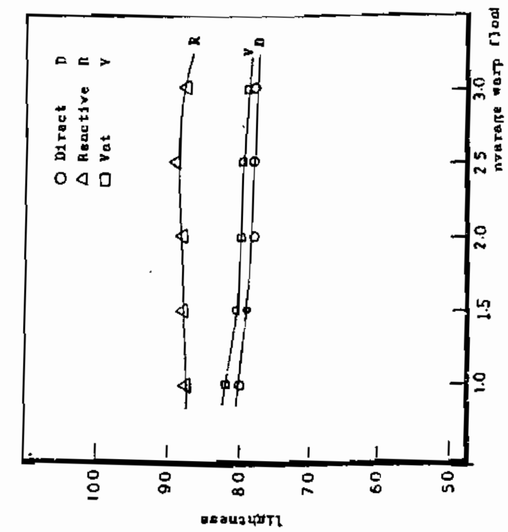


Fig. (7)
(Effect of avarage warp float on lightness)

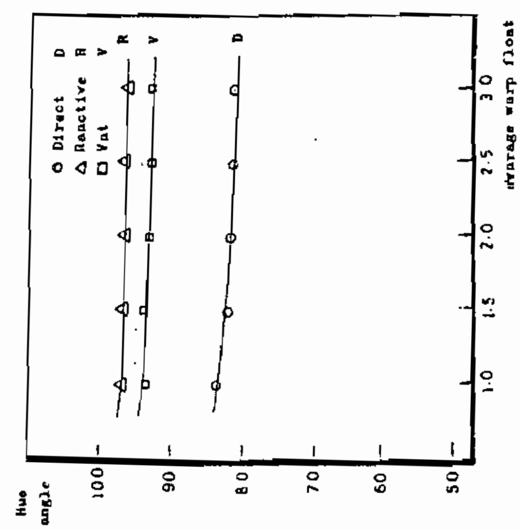


Fig. (6)
(Effect of avarage warp float on hue angle)

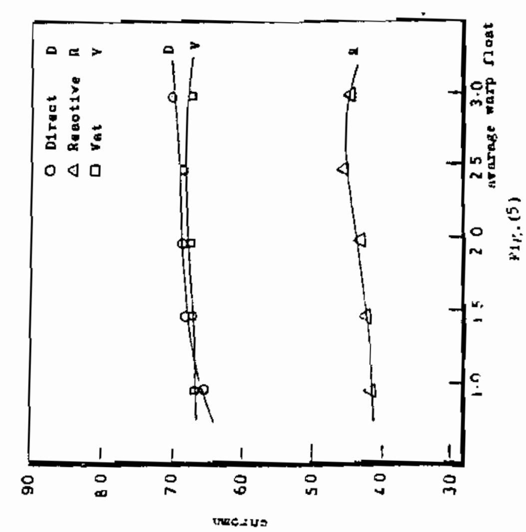


Fig. (5)
(Effect of avarage warp float on psychromatic chroma)

1- Combined scouring and bleaching
2- Dyeing of the bleached fabric with a direct dye
3- Dyeing of the bleached fabric with a reactive dye
4- Dyeing of the bleached fabric with a vat dye
5- Colour measurements.

(1) The effect of fabric structure (average warp float) on psychrometric chroma (C), Hue (H), and lightness (L) of dyed cotton fabric which weft density is 19 picks/cm.

- Fig. (5) shows the effect of fabric structure (average float) on psychrometric chroma of the dyed cotton fabric which were dyed by direct dyes (D), Vat dyes (V), and reactive dyes (R).

The results of these curves give an increasing of psychrometric chroma (C) by increasing the average float, specially in the curve of dyed fabric which dyed with direct dyes (D).

- Fig. (6) gives a spot light on the effect of fabric structure (average float) on hue angle (H) of the dyed cotton fabric which were dyed by direct dyes (D), Vat dyes (V) and reactive dyes (R).

The curves, give a clear results of a decreasing in the hue angle by increaing the average float.

- Fig. (7) shows the effect of average warp float on the lightness of dyed cotton fabrics which were dyed by direct dyes (D), vat dyes (V), and reactive dyes (R).

From the three curves D, V, R of this Figer, the increasing of the average warp float gives a decreasing in the lightness of the dyed cotton fabric.

(2) The effect of weft density on chroma, hue angle and lightness of dyed fabrics which were dyed with direct dyes:

- Fig. 8 shows the effect of weft density on the psychromitric chroma (C) at five different average float. In these curves, the increasing of weft density gives a decreasing in the psychromitric, specially at the fabric which have the low warp float (plain weave 1/1)

The Figure, also, shows that the psychromitric chroma at the 1/1 plain weave is lower than the chroma at the 3/3 warp rib plain weave and this phemena is bright in the Figure (5).

- Fig. (9) shows the effect of weft density on the hue angle (H) at five different average float. The results of these curves give an increasing of the hue angle by increasing the weft density.

The Figure, also, shows that the hue angle of colour of the fabric which have the low warp float is more than the hue angle of colour of the fabric which have the high warp float.

- Fig. (10) shows the effect of weft density on the lightness of dyed cotton fabric at five different average float.

These curves, shows that, when the weft density increased, the lightness of dyed fabric increased.

For other said, the lightness of the 1/1 plain fabric is more higher than the 3/3 warp rib plain fabric because of its lowest average float, that is seen that the lightness of the dyed fabric decreases by increasing the average float, and this phemena is bright in the Figuer No. (7).

CONCLUSIONS

The aim of this project is to investigate the effect of the average warp yarn float, weft yarn density and the type of dyes on, fabric colour properties. Five different average warp yarn floats, each of three different weft yarns density were woven then dyed with three different dyes which are direct dye, reactive dye and vat dyes.

A total of 45 different specimens each reperesents different case were tested to obtain psychromatric, hue angle and lightness. The results showed that bath weft density and warp average float have a remarkable effect on fabric colour properties.

From the results obtained, it has been found that there is:

- An increasing in the paychrometric chroma (C) by increasing the average float.
- An increasing of the average float decreases the hue angle.
- An increasing of the average float there are decreasing in the lightness.
- It has been also found that by the increasing of the weft yarns density there are:

  (i) decreasing in the psychrometric chroma.
  (ii) increasing in the hue angle.
  (iii) increasing the lightness of the specimens.

REFERENCES

1- Z. Gresicki, Watson's Text. Design & Colour, seventh Edition, 1975.

2- I. L. Finar, Organic Chemistry, Sixth Edition 1973.

3- D. B. udd and G, Wyssecki, "Colour in Business, Science and udusting" Johm Wiley, New York, third Ed., 1967.

4- L. Gall, in colour 73, Adom Hilger London, 1973.

5- colour measurement (Bayer Farben Revue No.3/1 Anni Berger, Amdreas Brockes) 15 Aug. (1941).

6- Introduction to colour measurement in Textile industry Robert Hirschler Unideo Service) 20 (1952).

7- Colour in Business, Science and Industry, Jadd Wyszecks 4 (1964).