EFFECT OF PRETREATMENT AND DYEING ON STRENGTH AND QUALITY NUMBER OF GIZA 75 COTTON FIBERS

تأثير الصباغة والمعالجات الكيماوية السابقة لها على كل من متانة الشد ورقم جـــــودة الشعيرات القطنية لصنف جيـــــزة ٧٥

BY

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الخلاصة ـ استخدم الميكروسكوب الضوئى العادى واختبار " Dumbel " المعدل فـــى دراسة تأثير كل من المعالجات الكيماوية السابق للصباغة مثل الغلـا والتبيض وكذلك الصباغة باستخدام سبعة أنواع مختلفة من الصباغات التى يكثر استخدامها فى مصانـــع الصباغة والتجهيز عن طريق تعيين رقم جودة القطن باستخدام المعادلة : ـ

$$Q.N. = \left(\frac{n_1}{n} + \frac{n_2}{2n} + \frac{n_3}{3n} \right) \cdot 100$$

وأيضا حساب نسبة تلف الشعيرات القطنية طبقا للمعادلة : ـ

$$\% D = \left(n_3 \div n \right) \cdot 100$$

حيث n_1 هى عدد الشعيرات تامة الانتفاخ n_2 هى عدد الشعيرات متوسطة الانتفـــاخ n_3 هى عدد الشعيرات عديمة الانتفاخ n هى عدد الشعيرات الكلى . وأوضحـــت النتائج أن الفقد فى متانة شعيرات القطن مقدرة بدليل برسلى يكون مصحوبا بانخفـــاض فى رقم الجودة مع زيادة فى نسبة تلف الشعيرات القطنية المختبرة . ووجد أن أقصى انخفاض فى رقم جودة الشعيرات القطنية تم عند استخدام صبغة Drimarene فى حيـــن أن أقل انخفاض حدث عند استعمال صبغة " Direct "

Abstract: The effect of chemical treatment on strength of dyed cotton fibres using a simple light microscope and "Dumbell" test was studied. The results indicated that the drop in strength of treated cotton fibres(scoured, bleached, and dyed with seven different dyes) was accompanied by a drop in quality numbers, or/and with the increase in the number of damaged fibres. For dyed cotton fibre, the maximum drop in quality number was higher with Drimarene dyes than that with Direct dyes.

1- INTRODUCTION

The textile industry in Egypt depends mainly on cotton and cotton represents 90% at least of its fibre consumption. It is well known that the Egyptian cotton has unique properties and is of high grades in comparison to other cottons produced elsewhere in the world. It is the first national crop in Egypt and the national income of the country depends to a large extent on it.

Damage may take place in cotton plant processes. It is propable that some degradation is caused by the standard cleaning, spinning and weaving in the manufacture of cottons. But generally it is known that the chemical treatments in the finishing processes really affect the fibre. The chances of serious deterioration are much greater.

It is evident from the experience in the industry that under certain circumstaces, cotton fibres are exposed to both physical and chemical damage, unless operations are carefully controlled.

The purpose of the present paper is to examine the effect of the dyeing treatments on the strength of Giza 75, cotton fibre and to follow-up the quality of the

fibre at these treatments, by microscopical test, with the aim of expressing the quality of the fibres from the strength point of view, with simple figures. In fact these are important to the spinners and to the dyeing and finishing especialists, and in general to the textile mills.

It is hoped that through these figures, one could rank cottons acording to their quality and resistance to damage when exposed to mechanical, chemical and weathering conditions, or when stored.

II. A COMPREHENSIVE SURVEY OF DEGRADATION MEASUREMENTS OF COTTON FIBRES[3-7]

The tests given here may be classified as follows :

A) Qualitative Tests

1- For swollen cellulose
   a- Zinc-chloride-iodine test.
2- For chemical damage
   a- Fehling's solution for hydrocellulose or oxycelluose.
   b- Turnbulls blue for oxycellulose.

B) Quantitative Tests:

1- For swollen cellulose
   a- Barium activity number of mercerized cotton.
2- For degraded cellulose
   a- Loss of weight in hot dilute NaOH for molecule length.
   b- methylene blue absorption for carboxyl groups.
   c- Copper number for aldehyde groups.
   d- Fluidity for molecule length.

With respect to the unreliable tests, it include the methylene blue test, diamine sky blue test, benzopurpurin test, indanthrene yellow test, Harisons test, and heat test.

II.1 Other Tests for Assessing Damage of Cotton Fibres:

II. 1.1: Congo Red Test:

This test is simply illustrated in soaking cotton fibres on a microscope slide for 5 min. in 9% NaOH, then washed and blotted dry,then soaked for 6 min. in a saturated aqueous solution of Congo red, then washed and mounted in 18% NaOH for microscopical investigation. Damageed portion of the fibres will be swollen and stained much darker red than the undamaged portions.

II. 1.2: Heat Damage of Acid Tendering Test:

This test is also a microscopical test. The cotton fibres which are suspected of damage by scorching may be mounted in 18% NaOH and examined after 10 min. The fibres will be swollen, but also nicked at short intervals by horizontal cracks across the axis of the fibre.

A similar but more pronounced response is observed in cotton fibres which have been tendered by exposure to mineral acids. The fibres are frequently segmented into short fragments upon swelling in the caustic soda. This phenomenon is sometimes refered to as "chemical sectioning".

II. 1.3: "Dumbell" Test:

The test is simply illustrated in cutting lengths of cotton fibre of about 0.50 mm from a bundle of fibres. The short lengths are mounted on a slide in 15% NaOH and examined microsopically.

In the undamaged fibres the secondary wall cellulose will swell and be extruded from the cut ends of the fibres forming dumbell shapes or mushroom beads at each

end of the fibre section. But if the primary wall has been damaged it will be weakened and unable to withstand the internal pressure generated by the swelling secondary wall. In damaged fibres the whole fibre swells more or less uniformly and there are no mushroom heads or dumbell formations.

The damage can be estimated by counting the number of each type of fibre present and a quantitative expression of the amount of damage in the cotton can be determined. Also it was suggested to calculate a "quality number", which is obtained by calculating the percentage number of well-swollen ends and divided by unity, also determined the percentage of medium swollen ends and divided by 2, also the percentage of unswollen ends and divided by 3. The sum of these figures gives the quality number, a figure less than 75 indicates damage.

III. EXPERIMENTAL ARRANGEMENT AND TECHNIQUE.

To examine the influence of chemical treatment on the strength of cotton, samples of Giza 75 cotton have been scoured, bleached then dyed with 7 types of commerical dyes, that widely used in dyeing mills. The change (if any) because of these treatments have been followed-up microscopically and mechanically by measuring the bundle strength (Pressely Index, P.I.).

The details of the dyes used are given in Table 1. In microscopic tests the dumbell test described in Part I of the project MS 851072 was used to assess the dgree of damge that has been occured to the fibre. Microscopical investigations using the dumbell test have shown that when the cotton fibres (dyed or not dyed) are placed in zinc chloride solution they show the forms shown in Fig. (1) with different propotions in the specimen examined.

In the mathematical analysis of assessing the quality of the fibres at any chemical treatment, type 1 was counted in the sample examined as n1, while type 2 was counted as n2, and type 3 was counted as n3, ..., and the total number of fibres examined is n, where $n = n1 + n2 + n3 \ldots .$ (1).

The quality number (Q.N.) which is used in the present work as a microscopic measure for quality is calculated by proportion from the following equation:

$$Q.N = \left(\frac{n1}{n} + \frac{n2}{2n} + \frac{n3}{3n} \right) \times 100 \qquad (2)$$

In another mathematical analysis for the same test the percentage of damaged fibres, i.e. type 3 only in which no bulging of the secondary wall is observed has been used as a measure of the quality of treated cotton under cosideration. The (%) damaged fibres is calcnlated from the equation:

$$\% D = \frac{n3 \text{ Damaged}}{n \text{ Total}} \times 100 \qquad (3)$$

IV. RESULTS AND DISCUSSION

Plotted in Figs. 2 and 3 are the values of strength (P.I) versus quality number (Q.N), and the values of the % drop in quality number verus % drop in strength. respectively. Statistical analysis has shown that tensile strength is positively correlateo with the quality number which is basically determined from microscopical examination of fibres. The correlation coefficient (r) is 0.849.

It is also interesting to find out that the % drop in quality number is positively correlated to % drop in strength (P.I), and the correlation cofficient (r) is 0.81.

The Q.N ranges between 93.0% (for raw ginned cotton) and 59% which has been obtained when the scoured and bleached Giza 75 coton was dyed by Drimarene. (See Table 2).

Plotted in Fig. 4 are the values of the % of damaged fibres (%D) versus the % decrease in fibre bundle strength. It is observed that generally the % decrease in strength tends to increase with the increase in the % of damaged fibres. This result and the result obtained between strength and Q.N. (Fig. 2) indicated that a relationship would exist between the two microscopical determinaions, i.e. the Q.N and the %D. Plotted in Fig. (5) are the values of Q.N versus %D for scoured, bleached, and dyed Giza 75. It is evident that generally high values of Q.N are associated with low values of % damaged fibres and vice-versa. In fact this result pointed to the suitability of using the % damage as a quick measure for fibre damage, since only one type of fibres (type 3) is counted under the microscope instead of counting each type. This will save time and effort, but the Q.N has the advantage of considering all fibres in the tested sample, which corresponds to the result obtained for strength, where the average strength of fibre bundle is recorded.

Shown in Fig. (6) is the block-diagram of the % drop in Q.N for dyed Giza 75 (relative to the original value of the ginned raw cotton). It is evident from the figure that the maximum drop in Q.N is obtained when the Drimarene dye was used, while the least was obtained with the Direct day. It is propable that severe damage to the primary wall has occured, when Drimarene was used. This is suggested from the large increase in the % of damaged fibres, i.e. those showing no bulging of the secondary wall.

V. CONCLUSIONS

1. The quality number (Q.N) of Giza 75 Egyptian cotton that has been scoured, bleached and dyed with seven different dyes ranges between 84% and 59%. The higher the quality number, the higher the percentage of undamaged fibres in the sample and vice-versa.

2. For scoured, bleached and dyed Giza 75 cotton the drop in strength was associated with a drop in quality number, or with the increase in the number of damaged fibres.

3. For scoured, bleached and dyed Giza 75 cotton, the maximum drop in quality number occared when Drimarene dye was used, while least drop occured when Direct dye was used.

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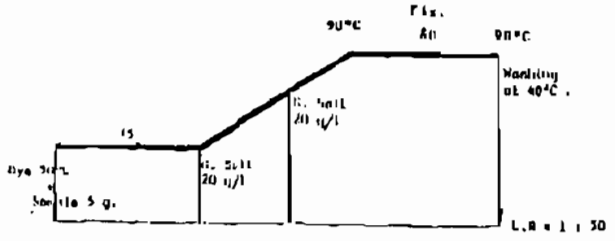
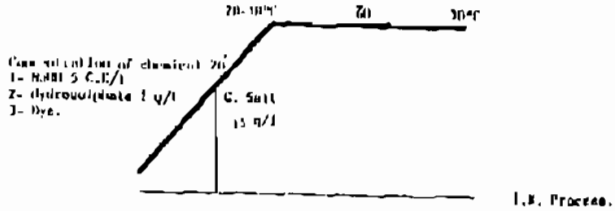
Table 1

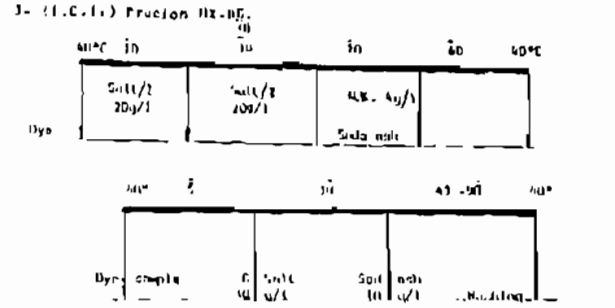
1- Direct Dyes (Solaris Yellow 4R).



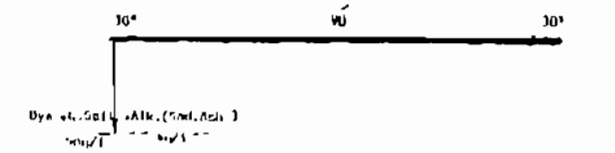
2- Vat Dye (Ostacron Yellow RG),



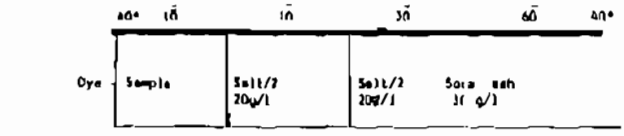
3- (I.C.I.) Procion Hx-8G.



5-(D.A.S.T.) Duasyn yellow M-4GL.



6-Levafix yellow E-GA.



7-Insoluble Azo Dyes Naphtol

Diazotization method:

1- 10 modified As G.
2- 2 c.c./l H_2O
3- 0.7 c.c./l Caustic soda 30 Bé.
4- 1 C.C./l methylate Salt
5- 10 C.C./l Turky Oil
6- 4 C.C./l Caustic Soda 30 Bé.
7- 15 g/l B- Salt.

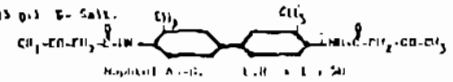


Fig. 1 Forms of cotton in Dumbell test (Fibres are immersed in iodo-zinc-chlorid solution)[1,2].

1 a. The Type 1 secondary wall bulges remarkably in both sides of the fibres.

1b. The type 2 secondary wall shows less bulging in both sides of the fibre .

1c. Type 3 No bulging of the secondary wall.

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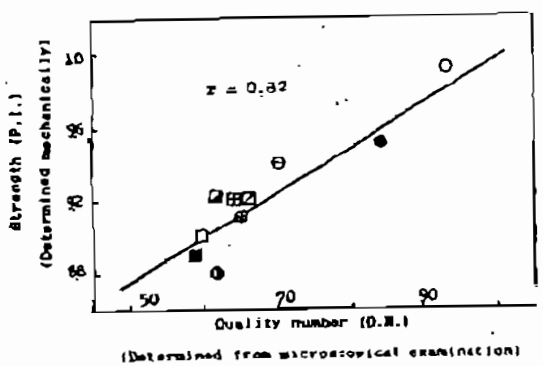

Fig. 2 Values of Strength Versus Quality Number for Dyed Giza 75

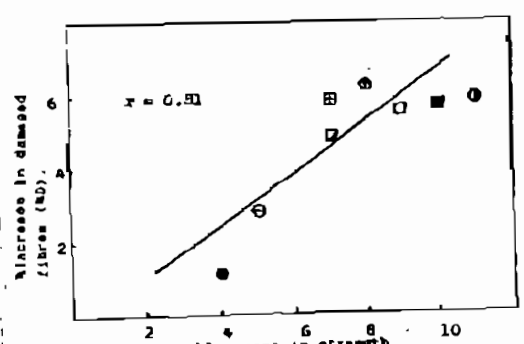

Fig. 4 %Decrease in strength versus %increase in damaged fibres (%D)

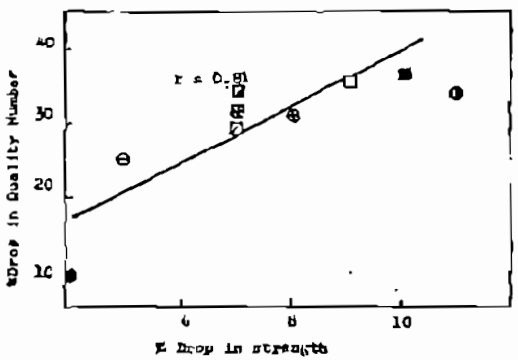

Fig. 3 Values of %drop in strength versus %drop in quality number

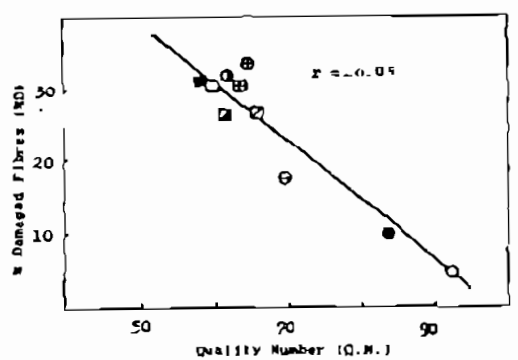

Fig. 5 Quality Number versus %Damged Fibres.

O Raw ginned
● Scoured
⊖ Bleached
⊕ Dyed with Levafix
◑ Dyed with Basilen
Dyed with Procion
Dyed with Drimarene
Dyed With Direct
Dyed With Naphtop
Dyed with vat

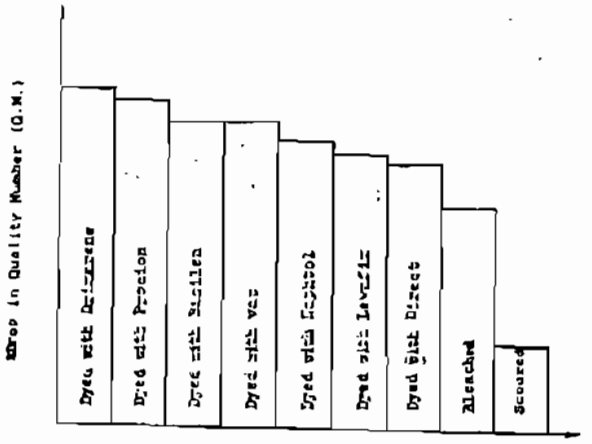

Fig. 6 Block-Diagram Showing the % drop in Q.N. With the Type of Dye-used.

Table. 2 Values of Quality Number (Q.N), % Damaged Fibers (%D) and Fibre Bundle Strength (P.I) for Giza 75

Treatment	Strength (P.I.)	%Damage (%D)	Quality Number QN(%)	%Drop P.I.	%drop Q.N.	%Increase in damage %D
Raw ginned	9.9	4.5	93	0	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dyed with Levafix	9.1	33.8	65	8.08	30.1	8.3
Dyed with Basilen	8.8	34.	62	11.11	33.3	5.9
Dyed with Procion	9.	30.5	60	9.09	35.5	5.6
Dyed with Drimarene	8.9	31.	59	10.10	36.6	5.7
Dyed with Direct	8.1	26.6	66	7.07	29.	4.0
Dyed with Naphtol	9.2	31.7	64	7.07	31.2	5.2
Dyed with Vat	9.1	26.7	62	7.07	33.3	4.0