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Study on Effect of Mordant on Tenacity of Carpet Piles

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ABSTRACT

It is clear that properties of carpet piles play the main role on the property of a carpet. In the present study the carpet piles are first dyed with natural and chemical mordants. After that the samples of carpet piles are divided into eight categories with different condition of mordants, and then a sample without mordants is treated to be compared with the produced samples. After the process of dyeing, tenacity and elongation of woollen yarns (e.g. carpet piles) are measured. Test results were analyzed by ANOVA (e.g. SPSS13 software) for all samples. The statistical method of Tukey and Duncan was used in order to classify and rank the properties of the woollen yarn. The results showed that the sample with natural mordants have the most tenacity in comparison with others. Mechanical properties of fibers and in the other words resistance against powers from the technical point of view are the most important properties of fibers. Also properties of cotton and wools depend on the complex relation between location position of fibers and their properties. Knowledge about properties of fibers is not sufficient for perception of properties of cotton and wools, because chemical mordants have the oxidation effect on woollen piles and attribute to decrease the tenacity of the samples. Also statistical results showed that there is no significant difference between elongations of the measured woollen yarns (e.g. samples of carpet piles). Finally, the results indicate that there is significant difference (e.g. Tenacity) between samples that depend on the kind of mordant.

Keywords: carpet piles, mordants, woollen yarns

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INTRODUCTION

An important parameter for woollen hand-woven carpets is its strength and durability. This parameter could be affected by the dyeing conditions. In natural dyeing conditions, with after chrome and meta chrome mordants and various pH's, different results are obtained for the strength characteristics of carpet piles. Mechanical properties of fibers depending on the dyeing conditions and different pH's would differ significantly [1, 2].

Also, properties of wool and cloths depend on the complex relation between the location of fibers and their properties. Knowledge about properties of fibers is not sufficient for perception of properties of wool and cloths. Generally, effective factors on the strength properties of fibers are related to the fiber structure parameters and its conditions. It's worth mentioning that chemical and physical properties of wool fibers depend on the moisture, temperature and their dimension. The Sistine part of wool has an important contribution to the excellent and priority of wool. Any change in the amount of Sistine will affect its property and quality. The two connection sulphur in the Sistine structure causes the relations to go to an equilibrium state. A relation of two sulphurs has been oxide and determined by the one remaining Sistine acid [3, 4].

Primitive analysis of wool as the consumed fiber in hand-woven carpets has been shown as the wool of carpet elements of carbon, Hydrogen, azotes, sulphur, and oxygen, which are all chemical compounds of wool. But hydrolysis of wool with acid or alkali has distinguished a mixture of amino acid and a Disulfide connection between two chains which has established a three-dimension construction. This factor causes lack of activity of wool in natural solvent which has breakage ability of hydrogen connections. Wool reactions depend on the peptide group which is in the Keratin molecular. The effect of consumed acid in fulfilled dyeing in wool depends on the damaging of peptide connections or salt connections. If acid has effect on the salty connection, it causes puffiness of fibers and its strength will be deducted against draught. Limitation of damaging by acid depends on the destiny of acid, heat degree and time of operation. When the acid drains out of the fibers due to washing, the salty connections of the fibers are established and become stronger. But effect of alkali in wool depends on the factors such as degree of heat and destiny and wool encounters with deduction of strength. But in pH more than 10, Disulfide connections start getting gently weaker, until they break. The operation is done in the hardest condition, peptide connection will be hydrolysis. Oxide materials usually influence the Sistine connection of wool which Sistic acid has been acquired from hydrolysis of oxide wool. Chromate or bi-chromate solvent which is used at the moment of dyeing, is a component with wool in acid or neutral state. Chromic acid has been composed with amino group in the width wise chains and in the fusing place of Disulfide connections. Absorbed chromic acid is revived and as a result it establishes a metal complex with fibers [5].

These types of compounds are important for dyeing wool with chromic colors. While cleaning wool from its sulphuric acid, chlorine, magnesium or choleric acid, cellulose impurities, there are places which need to be considered carefully since variations of acid solvents cause softness and hardness and also cause the wool to become fragile. Fixing the color depends on the mordant, so it is as important as dyeing. Some dyers believe that usage of mordant is necessary for all colors, so it could be said that if we want to fulfill dyeing completely keeping the color fixed, mordant is one of the necessity stages.

Metal salts, iron, chrome, tin, aluminium are materials which apply for mordant. Mordants of white vitriol have been used for desirable wool. Note that chrome mordant is a very good material for mordant of woollen fibers, but this material is sensitive to light and there is the possibility of unevenness in dyeing. Some dyers do not know iron mordants as the mordant because of the deduction of softness and usage of iron salt. Tin mordants have been used for acquiring the red and sometimes the yellow, orangey shades. The mordant method can be acted before or after dyeing [6].

MATERIALS AND METHODS

Washing and Preparedness

The test samples are washed to remove impurities and also starchy materials and spinning oils according to the Table 1. At first, detergent and sodium carbonate is added to the bathroom. The goods need to stay in the bathroom for about 30 minutes, which 10 minutes of it is the time it takes for the bathroom to get to 70 degrees, and 20 minutes is the time that goods need to stay in the bathroom temperature of 70 degrees. After that the goods are exited and washed.

TABLE 1. Goods preparation materials and condition

Materials and condition	Value
Natural Madder	30%
Acid acetic	3%
L/R	40/1
Temperature	$90^{\circ}C$
Time	$60^{'}$

Mordant Conditions by the Chrome Method

Dyeing and mordant is done in a procedure mentioned in Table 2. Mordant is done on the raw materials in the bathroom. Then we wait 5 minutes until we obtain a steady state which is needed to assure us that we have reached a homogeneous system. In the next step we increase the temperature of the bathroom to 70 degrees and keep this condition for 45 minutes which is the time needed for dehydration. In the mentioned condition, we have 2 bathrooms, one with sumac and the other white alum, having the bathroom with acid acetic 3%. As shown in Table 2 samples with code B1 and B2 indicate the mordant type sumac and white alum respectively.

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TABLE 2. Material and condition of bathroom mordant by Batochrome method

Type of mordant	Sumac 3%	White Alum 3%
Acid acetic	3%	3%
Temperate	70°C	70°C
Time	45'	45'
L/R	40/1	40/1
Sample code	B1	B2

Bath Chrome Dyeing

Dyeing is carried out according to Table 3. For this purpose; goods, color and necessity cooperative materials are added to the bathroom for dyeing. The boiling temperature is obtained in 15 minutes and the process of dyeing continues for 60 minutes at a temperature of 90 degrees. Note that in the After chrome method, the goods are not needed to be washed with water, so in the last 15 minutes the mordant is added to the goods in the same conditions. After that the bathroom should be discharged and goods washed according to the existence order in the washing part.

TABLE 3. Dyeing Materials and Conditions

Materials and condition	Value
Detergent(g/l)	3
Soda Ash(g/l)	1
L/R	40/1
Temperature	70°C
Time	20'

Mordant with After Chrome Method

Dyeing is done According to Table 4. First we enter the goods in the bathroom and leave them to adapt with the bathroom conditions. Then we increase the temperature to 70 degrees before adding the mordant and allowing them to stay together for 45 minutes. Finally the goods are taken out of the bathroom and washed. Note that the additive materials in four different dyeing bathrooms at the time of adding mordant vary. According to Table 4, various acids with different mordant conditions are divided to 4 bathroom conditions naming A1 to A4.

TABLE 4. Bathroom materials and conditions for mordants with after chrome method

Type of acid	Formic acid 3%	Oxalic acid 3%	Formic acid 3%	Oxalic acid 3%
Type of mordant	Sumac 3%	Sumac 3%	Ferro-sulphate3%	Ferro-sulphate3%
Temperature	70°C	70°C	70°C	70°C
Time	45'	45'	45'	45'
L/R	40/1	40/1	40/1	40/1
Code of sample	A1	A2	A3	A4

Dyeing with Meta chrome Method

Natural dyers with two different mordants with simultaneous conditions have been divided in two Groups which have been shown in Table 5. Also, the dying condition is shown in Figure 1.

TABLE 5. Dyeing condition with Meta chrome Method

Type of mordant	Potassium bichromate 3%	Copper sulphate 3%
Natural madder	30%	30%
Acid acetic	3%	3%
Time of mordant	45'	45'
Time of dyeing	60'	60'
L/R	40/1	40/1
Temperature of mordant	70°C	70°C
Temperature of dyeing	100°C	100°C
Code of sample	M1	M2

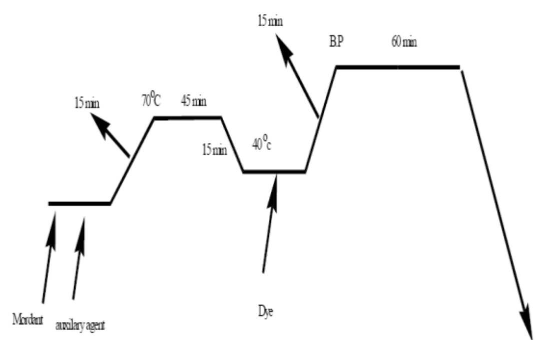

FIGURE 1. Condition of dyeing with meta-chrome method

Stress Test

Yarn and fabric of samples strength was measured on a SDL strength tester with constant rate of extension (CRE), at a clamp speed of 999 mm/min for yarn and 300 mm/min for fabric, and gauge length of 500 mm for yarn and 200mm for fabric. Thirty samples were tested in each case for yarn and five tests for each fabric. Table 6 shows test results of stress and strain at peak (%) of the yarns.

TABLE 6. Means of stress and strain of yarn samples

Samples Witness	Stress (cN/Tex)		Strain (%)	
	Mean	*C.V. (%)	Mean	*C.V. (%)
Witness	2.17	15.16	4.3	16.26
B1	2.06	33.11	4.33	23.66
B2	2.26	26.75	4.22	21.19
A1	1.97	30.6	4.3	25.17
A2	1.97	34.55	4	31.06
A3	3.07	28.58	4.74	26.78
A4	2.04	19.98	4.06	23.44
M1	1.38	34.26	3.81	27.24
M2	2.28	15.67	4.37	17.58

*: Coefficient of variation

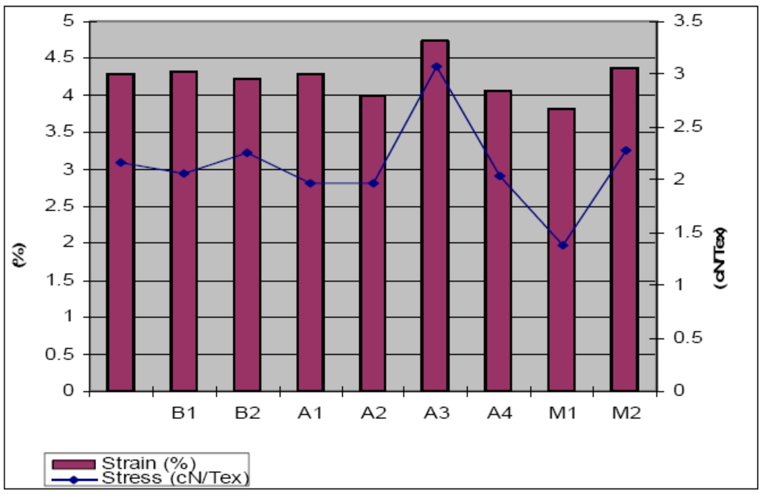

FIGURE 2. Diagram of tenacity and Strain at Peak of yarn samples

For each yarn property, there are thirty tests. Also in Figure 2, variation of tenacity and Strain at peak has been shown separately. Existence numbers in Table 6 indicate that wool has different coefficients, and suggests the use of woolly cloths which have lesser change coefficients and higher monotonousness. Table 7 shows statistical test results of the load of the fabrics (e.g. Tukey and Duncan test of load at Peak (Kg.f) with SPSS13 computer software analyzed) [7].

For each fabric, there are five tests. Results obtained for the load of the samples showed that the after chrome method causes less deduction in the strength (e.g. sample A3). Note that the A3 sample has the highest value among the other samples. This is due to the fact that the wool has been more proteinazation compared to the other samples. It is worth mentioning that wool with formic acid has more absorption of mordant and color. Also this fiber is resistant against acidic environments forming salty connections after watering. The Lowest value belongs to M1, because of the existence of chrome mordant and the effect of oxidation. The oxidation is caused by the deduction in strength of the sample. Note that sample M1 has destructive environmental effects.

TABLE 7. Statistical test results of load of fabric samples

Load (Kg.f)

	Samples	N	Subset for alpha = .05			
			1	2	3	4
Tukey HSD [a]	M1	5	2.1840			
	A2	5	2.2780	2.2780		
	A1	5	2.2820	2.2820		
	M2	5	2.3060	2.3060		
	B1	5	2.3800	2.3800		
	B2	5	2.4180	2.4180		
	A4	5	2.4540	2.4540		
	Witness of sample	5		2.5460		
	A3	5			2.9220	
	Sig.		.150	.157	1.000	
Duncan [a]	M1	5	2.1840			
	A2	5	2.2780	2.2780		
	A1	5	2.2820	2.2820		
	M2	5	2.3060	2.3060		
	B1	5	2.3800	2.3800	2.3800	
	B2	5		2.4180	2.4180	
	A4	5		2.4540	2.4540	
	Witness of sample	5			2.5460	
	A3	5				2.9220
	Sig.		.076	.117	.124	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

CONCLUSION

It could be noticed from Figure 2 that the After chrome method causes less decrease in the strength of the (A3) sample. The best mordant in this method is Iron with acid formic, which because of the protonization of wool with acid formic and the more penetration of mordant in wool fiber causes resistance after fiber draining. This resistance is due to the formation of salty connections. Also, different conditions of Sumac mordant with acid formic results the same. But for these similar results the Iron mordant would cause the color to be opaque, these causes less use the Iron mordant. In chromic mordant because of the oxidation, the strength of fibers decreases dramatically. This is could be seen obviously in M1. Also, in chromic mordant's, in addition of decreases of fiber strength, environmental issues come into play (e.g. environmental pollution).

In samples of clothes made of wool, considering the statistical results of Table 7 and comparing the wool samples, results show that experiments of yarn and cloths give similar results (e.g. strength results) with sample A3 showing the best.

In Table 7, a significant difference between the M1 and A3 samples with the other samples could be noticed while there is no signification difference between A1, A2, M2 and B1. Also, considering the witness sample and the other samples, the highest strength is for the A3 sample and the least strength is for the M1 sample. Note that these two samples have a significant difference with other samples. By considering the Duncan test which is more precious, cloths sample are divided to four different groups and the best method is After chrome and Iron chrome which have the highest strength. Finally, the A3 sample, due to the existence of Iron and creating stability in the sample in the way of creating connections, acts better than all other samples. This shows the most strength among all samples.

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