OPTIMIZATION OF CLEANING CONDITION OF HISTORIC TEXTILES BASED ON IRANIAN ANCIENT TEXTS

Mehrnaz Azadi Boyaghchi, Behzad Zolfaghari, Mohammad Mahdi Karim-Nejad
Art University of Isfahan

ABSTRACT

This paper studies the fourth principle of Allama Shirazi Kendi treatise related to the Hegira 11th century about use of two materials of Arabic gum and plant Seidlitziarosmarinus in order to remove pomegranate juice stains from textiles. The investigation with the aim of reviving the traditions is focused on realizing how and why the use of the mentioned materials in removing juice stains from cotton textiles is discussed. Since removing the pomegranate juice on cellulosic fibers because of chemical bond establishing with the fiber is difficult, materials used such as Arabic gum (Acacia Senegal) and Seidlitziarosmarinus (Chenopodiaceae) in terms of composition and effectiveness of the method has been studied experimentally. To simulate the experimental sample, parts of cellulosic fabrics was used and impregnated and stained with pomegranate juice. Highlights of this recipe are conditions and the execution of the mentioned process which by the CCD (Central Composite Design) is capable simultaneously design and optimize the independent variables such as temperature, time and other interfering factors in the cleaning operation. Evaluation of performance of materials used was done by a Reflection Spectrophotometer that while confirming the effectiveness of the material being presented, results in achieving optimal conditions on using materials with a high degree of desirability.

Keywords: Cleaning; Conservation; Historic textiles; Arabic gum; Ashnan.

INTRODUCTION

In the past that there was not present human-made detergent and cleaners, for cleaning and removing stains on textiles, the methods and materials have been used which were locally and effective. Allama Shirazi Kendi(2011) in his treatise related to the Hegira 11th century has offered a method for removing pomegranate stains of textiles which quoted in the final chapter of Heravi Medicine book. In this method use of two natural materials Arabic gum and plant Ashnanis recommended but there

is no information on the amounts of these two materials and how to use it. Given that nowadays use of secure and safe materials is in the consideration of conservators and, on the other hand any the material which is recommended to clean old fabrics, it is necessary to be evaluated prior to utilization (Eastop, and Brooks, M 1996 & Shashoua, Y 1996&Shashoua, Y1990).Hence, study on effectiveness and achievement to the optimum amount of introduced material seems to be necessary.

Arabic gum

Arabic gum is dried secretions obtained of stems and branches of Acacia. Arabic gum mainly formed of high molecular weight polysaccharides and calcium, magnesium and potassium salts which is produced by arabinose, galactose, rhamnose and glucuronic acid hydrolysis. More often it is used as an emulsifier, stabilizer and thickener.

Seidlitziarosmarinus (Ashnan)

Ashnan with the scientific name of Seidlitziarosmarinus is a drought- resistant shrub that is often growing as native and adapted species in deserts and salt fields of Dasht-e Kavir and Lut; Masilehdeserts, Damghan, Sabzevar, Khorasan, Kerman, Yazd and most of saline and alkaline areas of the Iran. This shrub belongs to Chenopodiaceae and has succulent, fleshy, cylindrical leaves that containing abundant minerals (Deymeh et al2012).The average plant height of two meters and a canopy covers up to one and a half meters. Its flowering time is in early September and its seeds fully achieved in November. Therefore the best time to collect seeds is October to December. It has extremely high absorbency for alkaline salts such as sodium carbonate and potassium compounds. For this reason, from the ash resulting by burning plant foliage alkaline material "Klyab" is achieved, which in industrial and traditional centers such as soap making, pottery, washing of silk yarns and glassblowing is used (Hadi, 2009).

LITERATURE REVIEW

Cleaning historic textiles is an irreversible action (Timar-Balazsy and Esstop, 2005).Intervention in the field of organic matter because of their structure is more sensitive. Hence the use of

appropriate safe and natural materials in this section is important. Wet wash is one of the proper ways for maintenance historic fabric (Timar-Balazsy et al, 1993). Only use of water as a solvent or a solvent interface to eliminate dirty and the factors that causes deformation fabrics is an effective method. But there are cases where water cannot clear alone. In the last few decades of twentieth century, many of publications have addressed this issue that during wet wash cloth, it may wipe out the woven important information (Information such as texture, color, etc.)(Eastop and Brooks, 1996; Hall and Barnett, 1985; Dodds, 1988; Brooks et al, 1994; Brooks et al, 1996; Johansen, 1999; Stauffer, 1998; Windsor, 1995).Thus, identification the operations which have minimum negative effects on historic textiles are of utmost importance.

METHODOLOGY

In order to simulate sample, fabric with cellulose structure made of cotton was selected. Before any action, to eliminate probable contamination and increase in hydrophilic properties, fabric in a bath contains 0.5 g detergent and 0.5 grams per liter caustic soda (pH = 8.5) for 30 minutes at a temperature of 75 ° C washed and then rinsed. Then samples in the environmental conditions dried. Then fabric was placed horizontally and free so that only two heads of fabric to maintain the position were involved. Pomegranate juice by pipette with the amount of 0.2 cc without spaces as a stain with a diameter of approximately 2.5 cm created on the fabric.

Ashnan and Arabic gum preparation and how to apply

Amount of 150 cc of boiling distilled water was poured on the 15g of plant Seidlitziarosmarinus (Chenopodiaceae) and the container was maintained on the magnetic bearing heater at a temperature of 50°C for 24 hours. Then the solution twice passed through the filter paper and the clear yellow solution with PH=7 was prepared. The present solution as a100% extract was considered. In order to ensure naturalness of used Arabic gum, it was tested by Infrared Spectroscopy (IR) and its purity confirmed.

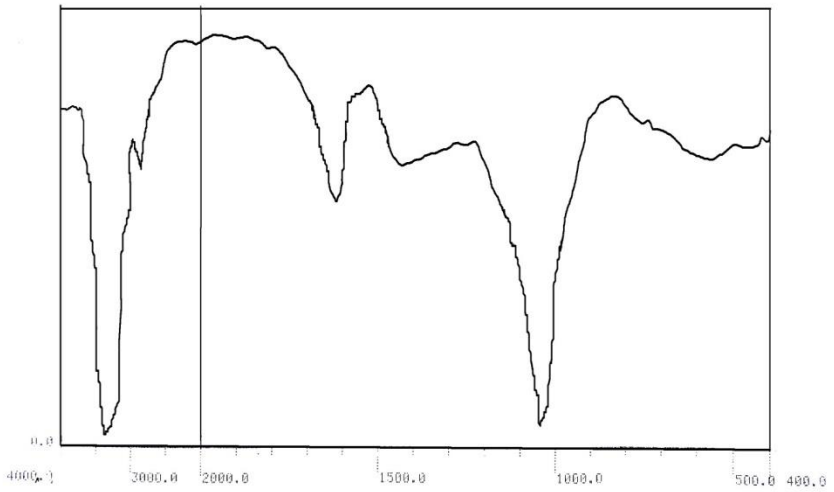

Figure1-*Infra Red Spectrum of Gum Arabic*

To apply Arabic gum (Acacia Senegal) and better uniformity of material, initially it was powdered and to achieve the same viscosity, constant concentration of Arabic gum (Acacia Senegal) with the amount of 30 grams per liter was used. Experiments based on the Central Composite Design (CCD) method were designed. Factors of temperature, time and the ratio of two materials Arabic gum and plant Seidlitziarosmarinus as independent variables and ΔE as a dependent variable were considered. Which the range of independent variables are defined as followed:

Time: 5-30 minutes
Temperature: 20-30°C
Materials ratio: 5-100 percent of the Seidlitziarosmarinus extract

Four values of Seidlitziarosmarinus extract (In percent)are required to run experiments based on CCD which to prepare 5% extract, 28.75% and 52.5% of Seidlitziarosmarinus, respectively 1, 5.75, and 5.10 ml of Seidlitziarosmarinus extract were brought to 20 cc volume with distilled water, and to prepare 100% extract, 20 cc. of Seidlitziarosmarinus extract was used and all obtained values to prepare materials were combined with 0.6 g of Arabic gum (Acacia Senegal).Prepared materials according to experiments design table with the same values moved on the stain and after spending a time under the desired temperature (See Table 1), treated samples at the same conditions rinsed and dried at environment conditions. In order to evaluate the performance of cleaning conditions, discoloration values (ΔE)was measured by American Reflectance Spectrophotometric Devices - X. rite model based on the following equation:

$$\mathbf{\Delta E^* = (\Delta a^* + \Delta b^* + \Delta l^*)^{1/2}}(1)$$

where ΔL* is the color lightness difference; Δa* is red/green difference and Δb* is yellow/blue difference. ΔE* is total color difference.(Nazari,A & Montazer, M & Moghadam, M.B & Anary-Abbasinejad, M 2011)

Data Analysis, discussion of results

The number of designed experiments using CCD (Central Composite Design) method with the obtained results by Reflectance Spectrophotometer (ΔE) is given in the table 1.

Table 1-*Values of temperature, time, extract and ΔE results for experiments*

Run	Time Min	Temp C°	Extract %	ΔE*
1	17.30	20.00	5.00	6.82
2	5.00	25.00	5.00	5.36
3	5.00	30.00	52.50	6.17
4	30.00	30.00	100.00	8.17
5	5.00	20.00	100.00	5.83
6	5.00	30.00	100.00	7.09
7	30.00	30.00	5.00	6.51
8	30.00	30.00	5.00	6.56
9	17.30	27.50	28.75	7.00
10	30.00	20.00	5.00	7.79
11	30.00	20.00	100.00	8.20
12	5.00	20.00	5.00	5.10
13	5.00	20.00	100.00	5.91
14	17.30	25.00	100.00	7.45
15	30.00	20.00	5.00	7.82
16	30.00	30.00	100.00	7.63
17	30.00	20.00	100.00	8.71
18	17.30	20.00	52.50	7.10
19	5.00	30.00	5.00	5.64
20	30.00	25.00	52.50	6.77

ΔE values represent color difference (stains discoloration) between treated samples and the control sample. Whatever ΔE value is less, discoloration is less too and treated sample is closer to the control sample and whatever ΔE amount is more, stain removing is more too compared to the control sample. Hence most stain removing with ΔE= 8.42 is related to the sample No. 17 which at 20°C for 30 minutes that treated with 100%extract. Least stain removing with ΔE= 5.10 is related to the sample No. 12 which at 20°C for 5 minutes that treated with 5% extract. Results using statistical Response Surface Methodology (RSM) and obtaining the statistical model were optimized so that

performance of washing operations could be related to the factors of temperature, time and extract concentration by quadratic equations.

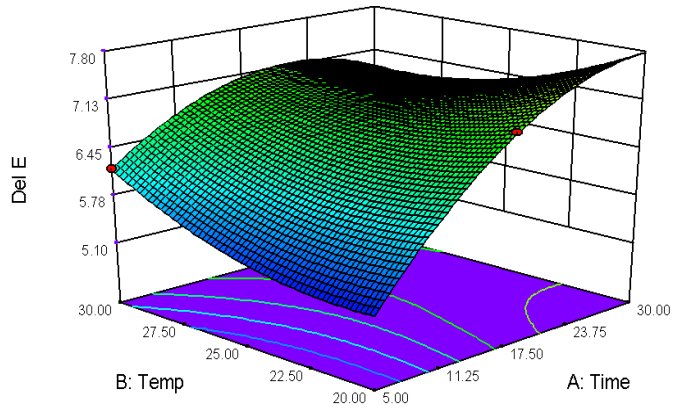

Figure 2-*Response Surface curve for discoloration values (ΔE) based on two variables of time and temperature variation*

Figure 2 indicates Three-dimensional curve of discoloration values based on two variables of time and temperature variation, which in this figure extract variable values are considered as a constant (52.50).This curve represents greater effect of time variable compared to the temperature variable on ΔE increase

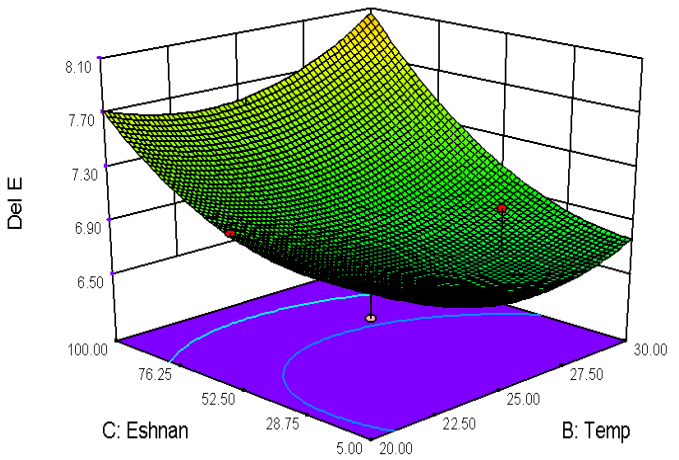

Figure3-*Response Surface curve for discoloration values (ΔE) based on variables of extract and temperature*

Figure 3 indicates Three-dimensional curve of discoloration values based on two variables of extract and temperature variation, which in this figure time variable values are considered as a constant (17.30). This curve represents greater effect of extract variable compared to the temperature variable on ΔE increase.

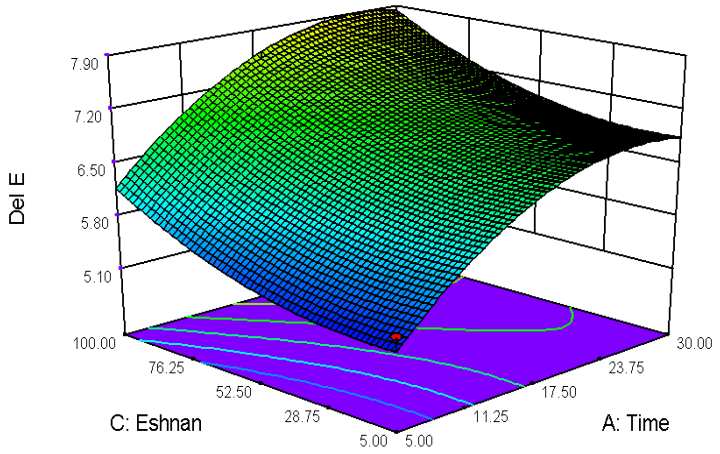

Figure 4-*Response Surface curve for discoloration values (ΔE) based on two variables of* extract and time *variation*

Figure 4 indicates Three-dimensional curve of discoloration values based on two variables of extract and time variation, which in this figure temperature variable values are considered as a constant (25.00). This curve represents direct and interactive effect of extract and time variables on ΔE increase.
By statistical analysis of variance (ANOVA), amount of equation meaningful was obtained that could be seen in Table 2.

Table2- ***Statistical analysis of variance (ANOVA),***

Source	**Sum of Squares**	**Df**	**Mean Square**	**F Value**	**P-vaalue Prob>F**
Model	18.67	9	2.07	33.98	<0.0001
A-Time	10.79	1	10.79	176.67	<0.0001
B-Temp	7.256E-003	1	7.256E-003	0.12	0.7374
C-Extract	3.86	1	3.86	63.23	<0.0001
AB	2.71	1	2.71	44.41	<0.0001
AC	7.158E-005	1	7.158E-005	1.172E-003	0.9734
BC	0.30	1	0.30	4.92	0.0509
A2	0.83	1	0.83	13.64	0.0042
B2	0.20	1	0.20	3.30	0.0992
C2	0.20	1	0.20	3.26	0.1010

Statistical analysis of variance (ANOVA) for data analysis in order to achieve the relationship between independent and response variables was used. This model is represented in the following equation:

$$\Delta E = +9.21506 + 0.38079 \times Time - 0.49272 \times Temp - 0.019016 \times Extract - 7.31637E\text{-}003 \times Time \times Temp - 3.94448\text{-}E006 \times Time \times Extract + 6.33310E\text{-}004 \times Temp \times Extract - 3.74875E\text{-}003 \times Time^2 + 0.011840 \times Temp^2 + 1.31102E\text{-}004 \times Extract^2$$

As can be seen the designed model of ΔE for treated samples from the statistical viewpoint in F Value equals to the amounts of P-value Prob> F (<0.0001) are significant (Table 1).This results show ΔE effectiveness for treated samples so that they are significant with high confidence level (99.99%).In the following, the best conditions that could be offered for washing in order of their desirability degree are shown in Table 3.

Table3-*Optimum conditions for washing*

Number	Tim Min	Temp C°	Extract %	ΔE	Desirability
1	30.00	20.00	100.00	8.42	0.920
2	29.88	20.00	100.00	8.42	0.920
3	29.43	20.00	100.00	8.41	0.918
4	30.00	20.04	100.00	8.41	0.918
5	28.89	20.00	100.00	8.41	0.916
6	28.17	20.00	100.00	8.39	0.912
7	30.00	20.30	100.00	8.37	0.905
8	26.81	20.00	100.00	8.35	0.901
9	30.00	20.00	93.55	8.30	0.886
10	21.48	30.00	100.00	8.12	0.838
11	21.28	30.00	99.99	8.12	0.838
12	21.64	30.00	100.00	8.12	0.838
13	22.23	20.00	100.00	8.12	0.837
14	25.09	20.00	91.27	8.12	0.837
15	21.67	29.93	100.00	8.12	0.836

Significant importance of these data is that the presence of Seidlitziarosmarinus (Chenopodiaceae) at the highest level (100%) has been confirmed. In other words, composition of the introduced material is effective and shows deep understanding of ancient Iranians on material and their performance.

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that combination of Arabic gum and Ashnan extract as a cleaner for pomegranate juice stains on textiles could be effective. On the other hand, because of thickening property of Arabic gum, it will be also provided in addition to prevent detergent movement out of the stains positions, the effective materials have a better performance. In other words, because of nearly neutral pH of introduced materials and their naturalness, historic fabric are in the lower range of the threatened and their utilization for the environment and conservator also has a lower risk. Temperature range close to ambient temperature and relatively suitable time are another features of this compound that makes possible its application to historic textiles.

REFERENCES

AlamehShirazi-kendi 2011, *TebeHeravi.Publications* of the Institute of Historical Studies, Islamic and Complementary Medicine, Tehran University of Medical Sciences

Brooks, M & Clark, C &Eastop, D and Petschek, C 1994, 'Restoration and conservation issues for conservators', in Oddy, A., ed., *Restoration: Is it Acceptable?,* British Museum Occasional paper 99, Department of Conservation, London, pp. 103-22.

Brooks, M & Lister, A &Eastop, D and Bennett, T 1996, 'Artefact or information? Articulating the conflicts in conserving archaeological textiles' in Roy, A. and Smith, P, eds., *Archaeological Conservation and its Consequences, Preprints of the Contributions to the IIC Congress, Copenhagen,* IIC, London, pp. 16-21.

Deymeh, H &. Shadizadeh, S.R&MotafakkerfardR 2012*' Experimental investigation of Seidlitziarosmarinus effect onoil–water interfacial tension: Usable for chemical enhanced oil recovery'*Sharif University of Technology Scientia Iranica.

Dodds, W 1988 'Consolidation of mud on a World War I uniform', *Australian Institute for the Conservation of Cultural Material (AICCM) Newsletter* 25, p. 7.

Eastop, D & Brooks, M 1996 'Difficult decisions in cleaning: the evidential value of soils and creases' in 2. *Ehemaligentreffen der Ahegg-Stiftitng, Referate der Tagung, ,* Abegg-Stiftung, pp. 10-19.

Eastop, D and Brooks,M1996, *To Clean or Not to Clean: The Value of Soils and Creases,* preprints of the 11th Triennial Meeting of the ICOM Committee for Conservation, Edinburgh, pp. 687-691.

HadiM.R, 2009*'Biotechnological potentials of Seidlitziarosmarinus: A mini review'* African Journal of Biotechnology Vol. 8 (11), pp. 2429-2431, 3

Hall, R and Barnett, J1985 'A fifth dynasty funerary dress in the Petne Museum of Egyptian Archaeology: its discovery and conservation', *Textile History* 16, no. 1, 1985, p. 12. http://www.irandeserts.com [Accessed 28 July 2013]

Johansen, K1999 'Perfumed garments, their preservation and presentation '...the good smell of old clothes" in Bridgland, J., ed., *Postprints of the 12th Triennial Meeting of the ICOM Committee for Conservation, Lyon,* James & James, London, pp. 637-42.

Nazaria, A, &Montazer,M &Moghadam, M.B&Anary Abbasinejad,M 2011,*Self-cleaning properties of bleached and cationized cotton using nanoTiO2:A statistical approach*,Carbohydrate Polymers 83, 1119–1127

Shashoua, Y1996, *Investigation into the effects of cleaning old, dyed, naturally solid textiles by By Aqueous Immersion*, Preprints of the 11th Triennial Meeting of the ICOM Committee for Conservation, Edinburgh, pp.714 -720.

Shashoua,Y 1990, *Investigation into the effects of cleaning natural woven textiles by aqueous immersion*, ICOM preprint 19th Triennial Meeting, Dresden, Germany, , pp. 315-319.

Stauffer, A1998 'Some comments on the cleaning of archaeological textiles' in Timar-Balazsy, <;.and Eastop, D., eds., *International Perspectives on Textile Conservation,* Archetype, London, pp. 159-61.

Timar-Balazsy, A,& Matefy, Gy and Csanyi, S 1993, 'Effect of stains and stain removal methods on historical textiles' in Bridgland, J., ed., *Preprints of the 10th Triennial Meeting of the ICOM Committee for Conservation, Washington DC,* James & James, London, pp. 330-5.

Timar-Balazsy.and Eastop, D 2005, *Chemical Principles of Textile Conservation.* Elsevier Butterworth-Henemann

Windsor, D.1995 'To clean or not to clean' in Ewer, P. and McLaughlin, B., eds., *Postprints of the AIC-Textile Speciality Group Meeting,* AIC, pp. 39-50.