TIMA Grant Project 2007-2008
Final Report Feb 2009
© Mandana Barkeshli
Title Historical and Scientific Analysis of Materials Used in Islamic Manuscript according Persian Historical Treatises

Aims

The aims of the research are to explore the materials used in Islamic manuscripts. There are number of recipes related to inks, sizing materials, dyes, pigments, binding mediums and their techniques of applications used in manuscripts, illuminations and miniature paintings that have been revealed by masters in Persian historical treatises during 15th to 19th centuries which have been over looked by scientists and conservators. Studding these historical references not only it gives a new chapter to identification of materials used in manuscripts and miniature paintings during the history, but it also helps to understand their role in their preservation due to the science behind their use.

Introduction

The art of the book which emerged in the great Islamic civilization is undoubtedly one of the most important achievements of the history of human civilization. Within the world of Islam, paper was produced for the first time in the eastern part of the Islamic world – or in Khorāsān – by Chinese captives sometime during the last decades of the first part of the 2nd Century AH (751 AD). This spread to other Islamic territories and, soon, paper became a significant item of the exports of the Islamic world. Persia, too, was considered as one of the most important centers of paper-making and it also acted as a bridge in transferring the art of paper-making from the East to the West. The growing demands of the scribes and the men of letters prompted the paper-makers of the mid-Islamic centuries and, subsequently, those of the Timurid and the Safavid eras to focus upon the aesthetical aspects of paper production and to produce a wide-ranging variety of paper. During these periods the masters introduced number of dyes, pigments, binding medium, inks, and their application techniques for colouring paper, purpose of calligraphy and paintings. There are number of recipes, revealed by masters in Persian treatises which have been over looked by scientists, conservators and art historians. Studding these historical references not only it gives a new chapter to identification of materials used in Islamic manuscripts during the history, but it also helps to understand their role in their preservation due to the science behind their use.
My earlier investigation has shown that art and science in Muslim artistic tradition merged strongly during the Islamic civilization. Moreover it has shown that artists and masters of calligraphy and painting had extensive knowledge in chemistry and the nature of materials beside artistic aspects.
Our analytical study on materials used in Islamic manuscripts is based on two phases: Historical analysis and scientific analysis.

Phase I- Historical Analysis

a- Classical References

Persian historical treatises related to the recipes of materials used in Islamic manuscripts from Taimurid, Safawid to Qajar period have been compiled and translated and a comparative study has been carried out. Addition to the manuscripts that had been compiled earlier about 23 manuscripts, eleven more manuscripts were added to the previous data including Persian literary references from Mughul period collected from India. The total number of manuscripts under study was 34 manuscripts

b- Materials

The recipes from the manuscripts under study have been categorized based on the materials used and different techniques that are practiced from 15th to 19th centuries as follows:

1. Dyeing Paper (gooneh karadn:

Based on our historical analytical research we found that although the basic dyes are limited in number a very large range of color shades is obtained by a series of intricate mixing and dosing. For obtaining different shades of colors simple techniques has been applied such as soaking in a diluted solution and drying in the sun to obtain a very light color, whereas with repeated soaking and drying in the shade bright or dark colors has been obtained. Besides primary and secondary colors many other shades of colors are described in Persian historical treatises fully in detail for dyeing purpose; bluish to greenish shade, greenish to purplish shades and yellowish to reddish shades. In the present research that has been conducted on the basis of the historical treatises under study, the process for extracting more than 50 different types of dyes has been identified, including primary and secondary colors and their various shades. From among these 52 shades of colors 16 organic dyes, 5 minerals and 10 mordents and acids that were used for colouring paper were identified.

The sample recipes of one of the color from primary dyes under the study have been shown below for the better understanding of the research methodology for the purpose of this report:

Yellow (*zard*)

Two techniques are described in different sources *Resaleh dar bayan-e-kaghaz morakab va hal-e-alvan* and *glzar-e-safa* according to which saffron and turmeric (*zardchoobeh*) are used for making yellow dye. For example *Seyrafi* in "*Gulzar-e-safa*" describes the saffron technique as follows:

Saffron (*zafaran*)

"Grind one *misqal* pure bitter saffron and place it in a glass. Add one *ser* (75 gram/cc) water and close the lid of it tightly. Keep it for three days in the sun light. After three days its yellow colour extracted and remaining will stay white. Filter the syrup with a piece of cloth, pour it into a china bowl and let it precipitate. Then pour it in a clean vessel and dip the papers in it thoroughly. Dry the papers by hanging them over a rope in the shade. Remember not to dry papers in the sun. After drying size and burnish the papers".

2. Sizing Paper (ahar zadan)

Sizing the paper is the process to prepare the surface suitable for writing, illuminating and painting. After the sheet is formed and dried, the cellulose fiber in paper can continue to absorb water, unless it has been sized or impregnated with some substance such as starch, glue or wax to prevent penetration. Different techniques have been applied for sizing the paper depending on the requirements such as soaking, or applying one or number of layers of sizing material on the paper surface by the help of a soft brush. Some of the scientific investigation has revealed valuable information on materials used in sizing process however there are number of sizing materials, revealed by masters in Persian treatises mostly belonging to late Seljuk and early Ilkhanid, Taimurid, Safawid and Qajar periods which have been over looked by scientists and conservators. Also referring to the historical treatises different particular sizes were used to make appropriate base or support for calligraphy or painting according to the requirements. Different types of papers such as single sheet of paper, two layered paper (*kaghaz-e do poosteh*) or three layered paper (*kaghaz-e se poosteh*), paper board (*muqqawa*) and album (*muraqq'a*) were made by using sizing materials.

Several sizing materials have been used according to historical treatises. According to the sources under study the materials can generally categorized as follows:

Proteinaceous materials including animal glue; starches from rice or wheat; vegetable gums; mucilage of plants and seeds; fruits and sugar.

Number of burnishing materials also has been used such as: agate stone (*aqiq*); jade (*yashm*); - ivory (*aaj*); glass (*zejaj*); crystal (*bollour*); Shell (*jis).*

The sample recipe of one of the sizes namely starch from rice and wheat under the study have been shown below for the better understanding of the research methodology for the purpose of this report:

Wheat starch*(neshasteh-e gandom*):
Wheat starch (*neshasteh-e gandom*) has been specified in two sources *Golzari safa* by *Seyrafi* and *Khat va Morakab* by *Hossein Aqili Rostamdari* as follows":
"For sizing a paper make some wheat starch paste, filter it follow by cooking. Then take a wooden board and cover it with felt (*namad*) or a muslin cloth. Take two bowls; pour the starch in one and some water in the other. Moisten a ball of cotton ball with starch and rub it over the paper. Finally take another piece of clean cotton ball, moisten it with water and rub it over the starched paper. This way the paper can be sized".

3. Pigments

According to Persian classical treatises the colours were classified among Persian artists as opaque colours (*jesmi*) and transparent colours (*roohi*).
Referring to historical sources we can identify different techniques in the making of pigments and dyes and the types of binding medium advised by the masters for particular paint and purposes. The sample recipes of one of the colors from primary pigments namely yellow under the study have been shown below for the better understanding of the research methodology for the purpose of this report:

Lead White (*Saffeedab, isfedaj*)
Lead white (Basic Lead Carbonate, $2pbCo_3$, $pb(OH)_2$ is an artificially made pigment commonly prepared by exposing lead metal to acetic acid vapours from vinegar. This method has been described by writers from an early date. In a sixteenth century technical manual *Sadiqi Beg Afshar*, Chief Librarian to Shah Abbas I, in *Qanoon-al-Sovar* describes a modification of this method that involves heating lead and then treating it with vinegar. He has described lead white (*safeed-ab*) pigment in his book, "*Qannon-al-sovar*" as follows:
"Put the required amount of lead in a proper terracotta (*sofali*) container. Place the mentioned pot on the fire and heat it to a degree where the content (lead) turns into liquid. Stir it constantly using an iron spatula until the melted lead solidifies like ashes (*khakestar*). It will (then) turn into a dark dust-like substance like collyrium (*surma*) and (eventually) it will catch fire and glows. Seal the container tight and do not let any openings. This (dark substance) collyrium (*surma*) like has to be cooked thoroughly and washed with salt water. After washing it for three times add to it sal-ammoniac (*naushadur*) and vinegar and set to bray. (Add water and) remove the sal-ammoniac (*naushadur*), then dry and set to bray. Do the process of washing, drying and braying several times until it is purified."

4. Binding Mediums (bast)

Before the prepared pigments are used, it is required to mix it with binding medium, so it can stick to support properly. Different binding mediums were used according to nature of support, nature of pigment and style of painting. The main binding medium is from vegetable source and animal sources as follows:

Referring to historical sources we have identified different techniques in the making of binding medium advised by the masters for particular paint and purposes. The sample recipes in regards to use gum arabic to mix the color of verdigris as one of the primary colors under the study has

been described in *Haliat-al-ketab* and is shown below for the better understanding of the research methodology for the purpose of this report.

Mixing verdigris (*zangar*):
In Safawid text, "*Haliat-al-ketab*", the way of preparing paint for use by mixing verdigris pigment and binding medium is explained in detail as follows:
"Put verdigris in a piece of cloth and place it in an earthen dish. Add a drop of white vinegar or lemon juice; rub it with finger till it is mixed thoroughly. Add some thrashed and cooked gum-arabic, mix it well and use it."

5. Different kinds of Brushes

Once the Persian painter had prepared pigments and paper, his final task was to make his brushes. According to classical texts hairs from a squirrel's tail were the most desirable for painter's brushes. The long hairs of Persian cats also enjoyed favour with artists. Having separated the hairs according to size, the artist would choose only those of exactly the same length. He would lay them together and thread them through a quill, pulling them out at the narrow end. The brushes ranged from extremely fine to thick, enabling the artist to achieve seamless precision in his painting and a calligraphic, virtuoso line in his drawings. The sample recipes for making brush's artist under the study have been shown below for the better understanding of the research methodology for the purpose of this report:

Squirrel's Brush
Sadiqi Beg has describes the method of brush making in his book "*Qanoon-al-sovar"* as follows:
"The brush used for painting should be made out of hair from squirrel's tail. Take out suitable amount of hair by separating them with a comb. Cut the sides and give the desire shape to it. Make sure no broken hair is left. Tie three parts of the hair and pass it through a goose quill".

6. Inks:

Recipes of inks from Persian historical treatises under study were identified. Comparative study needs to be made on different types of inks from these sources. The category of different types of inks were prepared based on the ingredients of the inks and their relative names mentioned by the masters in literary references. The sample recipe of one type of ink namely gall ink *(mazoo*) under the study has been shown below for the better understanding of the research methodology for the purpose of this report:

Gall Ink (*mazoo*)
Soltan Ali Mashhadi, in his book "*Serat al Sotour"* explains the preparation of gall ink. In his recipes he mentions about certain type of alum that if it is used can stabilize the ink as follows:
i. In order to create Ink these ingredients are needed: One portion of good quality Lamp Black *(doodeh)*), one portion alum (*Zaj*), two to three portion gall (*Mazoo*) and four portion good quality gum. Put gum in water until the liquid takes the form of honey and after that, bray it for 2 to 3 hours and pulverize it for 100 hours (5 days).
Using a kind of vitriol (*zamah*) is much better than alum (*zaj*) since alum can harm the lamp black. Boil the Gall until the liquid is clear and add the vitriol to the gall liquid. Afterwards add the liquid in small portions to the black lamp, bray, and test the new made ink until it can settle nicely on paper. Be reminded that the more you bray, the better the quality of the ink."

c- Techniques

Different techniques that are used in obtaining different layers of painting from the support layer to ground layer and finally the paint layer have been investigated during the study. Different techniques on each category have been carried out based on the comparative study from the classical texts. To get the better understanding in the research methodology of these aspect different techniques found on vermilion (shanjarf) has been shown below:

Vermilion (*shanjarf*)

The first technique of making vermilion is described in "*Savad-al-khat* by *Sultan Ahmad Majnoon Heravi*., "*Golzar-e-safa* by *Seyrafi*,. "*Morkab sazi va jeld sazi* by *Ali Hosseini*, "*Medad-al-khotoot* by *Mir Ali Heravi* and in *Resaleh dar bayan-e-khat va morakab va kaghaz va sakhtan-e-rangha* and *Resaleh-e- Tala va noghreh va hal kardan -e-an* by anonymous authors almost in the same way as follows:

"The best vermilion (*shanjarf*) is made in Europe and Rome. For making this pigment, a lute mixture shall be made out of clay and mud that is left out in bottom of streams, marshmallow flower (*gul-e-khatmi*), hair of human's head and bran (*sapus*). Rub this mixture thoroughly and make a paste. Take a glass of bottle and place half of the bottle the paste (*mutaiyan*) and dry the paste completely till no moisture is left. It is better if glass bottle is clear (*safeed*). Mix one *mann* sulphur (*googerd*) and half *mann* mercury (*simab*). For obtaining better quality, mix equal amount of sulphur (*kibrit*) and mercury. Bray them, pour it in the glass bottle and cover the tip tightly. Make a small hole on top of the glass bottle, the same size as a packing-needle (*sozan juwal-duz*). Blow burning charcoal from dawn to noon into it. Continue the process till black smoke comes out of the hole. As soon as black smoke is replaced with white and yellow smoke, stop the blowing and immediately, close the tip of the bottle tightly. Now all mercury and sulphur are melted and good quality of vermilion is obtained. The process of braying is very important. It should be brayed with extract of sour pomegranate drop by drop on top of a stone till it becomes soft and no large particles be left out. Place (fine vermilion) in a bowl; (add water) and wash hands and stone with warm water (in it); keep it for two to three hours till its bile is collected in the bowl. Drain the bile and remove the pure pigment which is left out in the bottom of the bowl into the clean terracotta earthenware (*sufal*) that has not been in any contact with water, so that the pigment dries fast. Whenever vermilion (*shanjarf)* is required to use, add a small amount of watery glue (*sirishim*) or gum (*samq*) to it and use it".

Phase II- Scientific Analysis

a- The Most Recommended Materials

These above study will help to explore the role of materials used in Islamic manuscripts and their possible preventive measure due to the science behind their use in future.

In this regard the most advised materials and recommendation that the masters have made based on Persian literary references are identified and recorded for further scientific investigation.

b- Exploring Secrets behind the materials

Following the earlier studies based on historical recipes of medieval period on saffron as inhibitor to prevent the destructive effect of green verdigris pigment (See Fig. 1-5) and henna dye in certain ratio as a disinfectant in paper dyeing process (See Fig. 6-10) it has been tried to explore more secrets related to the materials that may have been used as preventive measures. In this regard It has been explored more text related to certain materials that may help to lead us towards the secret behind the stability of the Persian manuscript and miniature paintings. This study needs further scientific research in the future plan.

c- Future Scientific Investigation

Based on the above investigations on the exploring the secrets and the most advised materials that the masters highly recommended the following scientific research methodology is suggested:

i. The sample of materials used in the Islamic manuscripts and miniature painting based on historical recipes under study to be made and experimented.

ii. Different techniques of preparation of materials based on the category of recipes under study to be made and experimented.

iii. The use of certain herbs, plants, minerals and additives that are mentioned in the classical texts as preventive measure and stabilizer for the certain materials needs to be thoroughly studied.

iv. Chemical composition of these materials to be studied in detail.

v. Samples to be prepared in different ratio for scientific analysis.

vi. A scientific comparative study to be made on the samples against the aging.

vii. Different property of these materials related to their quality as preventive measure to be tested and to be investigated by the relevant laboratory equipment.

d- Past and Future Articles and book publications

Number of articles related to the materials used in Persian medieval period is published which is listed below. The Islamic Manuscript Association (TIMA) grant made it possible to investigate and study further on the historical recipes. These studies are documented and articles and a book publication are under progress to introduce these valuable materials to elevate our understanding on Materials and techniques that are used in Persian medieval period.

e- Financial Summary

Expenses	Local Currency	Pounds Sterling
Research Assistants: RM1500 per monthx9 months = Rm13500	RM 13,500	1923.08
Scientific consultant: Fee: RM5000	RM 5,000	712.25
Editor: Fee: RM3000	RM 3,000	427.25
Travel: Iran: To Collect Data Airfare: RM2500 Two weeks: per diem: Rial500,000x14days=Rial7,000,000=$750	 RM 2,500 RM 2,482	 356.13 352.50
India: To Collect Data Airfare: RM2500 Two weeks: Per diem Rupees3600= $100x14=$1400	RM 2,500 RM 4,634	356.13 658
Miscellaneous	RM 1,500	214.66
Total	RM 35,116	£ 5,000

List of the Published Articles

Barkeshli, M. Traditional Preventive Measures Used in Persian Manuscripts and Miniature Paintings: Historical and Scientific Analysis of Iranian Illuminated Manuscripts and Miniature Paintings, Golestan Honar, Quarterly on the History of Architecture, No.16, Summer 2009, ISSN 1735-3890

Barkeshli, M. Sharing Good Practice, Conservation Issues in Asia: Traditional Preventive Measures Used in Persian Manuscripts and Miniature Paintings, Asian Regional Cooperation Conference, New Delhi, December 24, 2008, INTACH

Barkeshli, M. Historical and Scientific Analysis of Iranian Illuminated Manuscripts and Miniature Paintings, Contributions to the Symposium on the Care and Conservation of Middle Eastern Manuscripts, The University of Melbourne, Australia, 26-28 November 2007, The University of Melbourne, Published by Minuteman Press: Spencer Street, Melbourne, 2008, p. 74-88, ISBN: 978-0-7340404-7-3

Barkeshli, M. Historical and Scientific Analysis of Materials Used in Iranian Paper Dyeing Process with Special Reference to Henna, under publication in ICOM Committee for Conservation (ICOM-CC) Preprints, 15th Triennial Meeting, Delhi, India, 2008, p. 255-263, ISBN :978-81-8424-344-4

Barkeshli, M. Historical and Scientific Analysis on Sizing material used in Iranian Manuscripts and Miniature Paintings, American Institute for Conservation of Historic and Artistic Works (AIC), The Book and Paper Group Annual, Volume Twenty-two 2003, USA, 2003, p. 9- 16

Barkeshl,. M. pH Stability of Sffron Used in Verdigris as an Inhibitor in Persian Miniature Paintings, in Restaurator, International Journals for the Preservation of Library and Archival Material, Volume 23, p.154-164, 2002, issue dedicated to the 13th ICOM Committee for Conservation Meeting, Rio de Janeiro, 22-28 September, 2002, ISSN : 0034-5806

Barkeshli, M. The Presence of Saffron in Persian Miniature Paintings and its Preventive Role for the Destructive Fffect of Verdigris, Published in ICOM Committee for Conservation Journal, 12th Triennial Meeting, Lyon, *France*, 1999, Vollume II, p.489-494, ISBN :1873936923