Asian Journal of Home Science, **(June, 2011) Vol. 6 No. 1 : 1-4**

Research Paper :

Utilization of aloe vera for dyeing natural fabrics

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Received : *December, 2010;* **Accepted :** *January, 2011*

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ABSTRACT

In this study, Aloe vera (*Aloe barbadensis)* was used for furnishing colour to textiles. This appears to be first novel and unique exploitation of *Aloe vera* for dye application on different natural fibres. Dye was extracted from fresh aloe solution obtained from churning whole Aloe vera leaf in a mixer. The dye thus obtained 'chrysammic acid' could be easily applied on silk and wool at lower pH which rendered rich golden yellow colour. Washing deepened the colour which could be advantageous to the consumer. The dye could be used on cotton with the help of different mordants to produce different colours varying from yellow, pink, khaki to brown.

Srivastava, Avernita and Singh, T.G. (2011). Utilization of aloe vera for dyeing natural fabrics. *Asian J. Home Sci.,* **6** (1) : 1-4.

Key words : *Aloe barbadensis,* Chrysammic acid, Grey scale, Mordant, Wash fastness

The consumers, the world over have realised the importance of eco-friendly, biodegradable natural dyes which are being encouraged and preferred by everyone. Natural dyes have no health hazards or disposal problems but on the contrary act as a health care. Benefits of using natural dyes and finishes for textiles can be numerous. In its preparation and application, no or only mild chemical reactions are involved which are unsophisticated and harmonised with nature. Fabrics dyed or finished with natural herbs can render added positive effects on the health of the wearer. It is well known that skin absorbs some elements which come in its contacts. This may be used to provide softening of skin, soothing and healing effects by finishing or dyeing of textiles or garments which are in constant touch with the skin always.

Aloe vera is considered as a miracle plant with all its virtues like healing properties, analgesic effect, antimicrobial properties, anti radiation, detoxifying agent, moisturising and anti ageing mechanism. Both oral intake and topical dressings have been documented to facilitate healing of any kind of skin wound, burn, or scald. It is also found to have antimicrobial properties.(Kumar and Krishaveni)

Indian Aloe

Scientific name: *Aloe barbadensis*
Family: Liliaceae
Hindi name: *ghee kunvar, ghrita kumari*

Aloe vera is a perennial plant that belongs to the lily family. It is not a cactus, even though it looks like a cactus. It grows wild in Madagascar and on the African continent, is a native of North Africa, Canary Islands and Spain. Because of its therapeutic properties, it is now commercially cultivated in the United States, Japan, in the Caribbean and Mediterranean countries. Now it is also found all over India.

Physical appearance of aloe plant:

Aloe plant is coarse looking, with a short stem, 30-60cm in height. Leaf size is approx. 38cm long, 10cm broad and 1.9cm thick and is densely crowded. The leaves are fleshly tapering to a blunt point, smooth, pale green, having thorny prickles on their margins. The plant is found throughout our country (Pandey, 2006).

The aloe constituents are derived from the aloe leaf which consists of three primary sections:

– The rind (photosynthesis takes place here with sap contained in the pericyclic transport tubules- xylem and phloem),
– The mucilage (container) layer and
– The parenchyma or gel fillet (storage) layer.
– Chrysamminic acid
– 2,4,5,7-Tetranitrochrysazin
– 1,8-Dihydroxy-2,4,5,7-tetranitroanthraquinone
– 1, 8- Dihydroxy-2,4,5,7-tetranitro-9. 10-anthraquinone

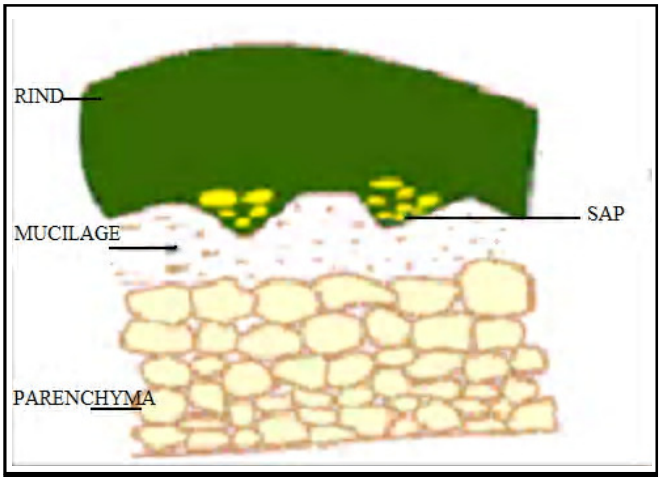

Fig. 1: Cross Section of an aloe vera

Formula: $C_{14}H_4N_4O_{12}$

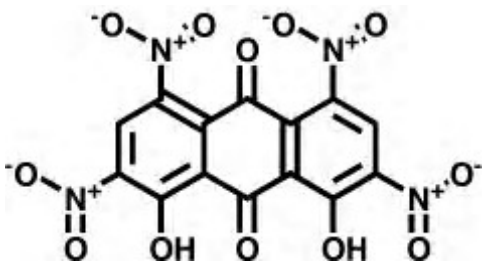

Fig. 2: Structure

EXPERIMENTAL PROCEDURE

- Fabric: plain weave cotton (Warp: 100, woof: 80, thread count: 100 x 80 *i.e.*180), Mulberry silk, plain weave and pure wool fabric.
- Aloe vera herb *i.e. Aloe barbadensis* (procured locally)
- Laundrometer

In the present study an attempt was made to obtain a dye from fresh leaves of *Aloe vera*. Since literature was not available in the mentioned field, numbers of trials were made and different experiments were conducted to dye cotton, silk and woollen fabrics. Samples were treated as direct dye, acid dye and mordant dye. After this, assessment of wash fastness of the dyed samples was done.

Whole leaves of *Aloe vera* were taken, and churned into a mixer. This 100% solution was used for dyeing.

Dye extraction:

Water extraction:

Aloe leaf solution was boiled in water. Attempt was made to dye cotton.

Alcohol extraction:

50 ml aloe leaf blend was added to 100 ml solution containing 60% ethanol and 40% water. It was then kept in orbital shaker (at room temperature) for 24 hours. After that it was taken out and cotton plugged. Next day it was left open for the alcohol to evaporate and the dye extract was left behind. Dyeing of cotton, silk and wool with this extract was tried.

Dyeing procedure:

- Treated as a direct dye
- Treated as acid dye
- Treated as mordant dye

Table 1: Procedure for dyeing

Sr. No.	Procedure		Fabrics
1.	Treated as direct dye	Aoe solution + nitric acid + common salt.	cotton
2.	Treated as acid dye	Aloe leaf solution + concentrated nitric acid	Cotton, silk, wool
3.	Treated as mordant dye	Dyeing after cationisation* of cotton	cotton
		Aloe solution + nitric acid + common salt + sodium hydroxide	cotton
		First treated with myrabolan + ferrous sulphate. Then dyed with aloe solution + nitric acid.	cotton
		First treated with myrabolan + alum. Then dyed with aloe solution + nitric acid + sodium hydroxide	cotton
		First treated with tannic acid + ferrous sulphate. Then dyed with aloe solution + nitric acid + sodium hydroxide	cotton
		First treated with alum + ferrous sulphate, then dyed with the aloe solution + nitric acid + sodium hydroxide.	cotton

* Cationisation of cotton was done by treating it with cationising agent namely, Optifix EC LIQ (procured from Clariant India), 5% owf, 1:50 MLR, at room temperature for 30 minutes. The cationised cotton was then dyed with the aloe solution + nitric acid in a bath and after 10 minutes, sodium hydroxide was added. Dyeing was done at boiling temperature and MLR 1:30.

Wash fastness test was carried out:

Wash fastness of dyed samples was assessed using ISO standard test no. 3. Specimens were prepared as specified in the test and treated in 5 g/l soap at 60° C for 45 minutes in 1:50 MLR in laundrometer. After the treatment, the samples were rinsed in cold running water for ten minutes, squeezed and dried in air. Assessment was done by grey scale.

OBSERVATIONS AND ANALYSIS

In the study possibility of dyeing cotton, silk and wool with aloe leaves was explored. Because of the lack of literature, numbers of trials were made and different experiments were conducted to achieve colour on cellulosic and protein fibres.

Natural dyes also fall under different dye classes as direct, acid, disperse, vat and mordant. Tannins such as *harar* (myrabolan), tannic acid etc are considered natural mordants. By first dyeing, let us say cotton with these compounds, one introduces additional hydroxyl and carboxylic groups in the fibre. These groups by themselves can only increase the dye uptake of basic dyes such as berberine. Mordants are useful only with dyes which have electron donating groups (o-hydroxy) which are capable of forming a complex with transition metal ions (Gulrajani, 1999).

Identification of dye:

Chrysammic acid is an acid dye and also the investigator was able to achieve colour on cotton with different mordants. When these fabrics were tested (IS-4472) the dye was identified to be an acid mordant dye. But it is possible that aloe leaves contain a number of dyes. The main colouring pigment in leaves is chrysammic acid which yields a golden yellow colour on protein fibres.

Since wool and silk have cationic groups in the form of protonated amino groups, these fibers can be dyed with 'natural acid dyes' under acidic pH, in the same manner as synthetic acid dyes. To attain colour on cotton different methods were tried. As it does not have any cationic sites for attachment of dye to the fibre, so an attempt was made to create affinity in cotton for this dye by introducing cationic sites in the fibre. This can be done by pre-treating cotton fabric with a cationising agent. This is in accordance with a study done on lac dye which is an acid dye. In this study cotton was firstly cationised and then dyed. Optimum conc. of cationic agent was 5% (Gupta, 2000).

This therefore appears to be first novel and unique exploitation of aloe plant for dye application on different natural fabrics. The investigator could not optimise the strength. Main emphasis was on obtaining different range of colours.

Wash fastness:

Colour change after washing of the dyed samples was observed. It was found that the dye showed excellent fastness on silk and wool when dyed as an acid dye. The shade of the dye had deepened and became brighter after washing. These samples were showing outstanding wash

Table 2: Results of dyeing with aloe leaves

Sr. No.	Procedure		Fabrics	Results
1.	Water extraction		Cotton, silk, wool	No colour
2.	Alcohol extraction		Cotton, silk, wool	No colour
3.	Treated as direct dye	Aloe solution + nitric acid + common salt.	Cotton	No colour
4.	Treated as acid dye	Aloe leaf solution + concentrated nitric acid	Cotton, silk and wool	Golden yellow colour on silk and wool; no colour on cotton
5.	Treated as mordant dye	Dyeing after cationisation of cotton	Cotton	Pink shade was seen.
		Aloe solution + nitric acid + common salt + sodium hydroxide.	Cotton	Light pink colour was seen on cotton.
		First treated with myrabolan + ferrous sulphate. Then dyed with aloe solution + nitric acid.	Cotton	Light khaki colour
		First treated with myrabolan + alum. Then dyed with aloe solution + nitric acid + sodium hydroxide	Cotton	Khaki brown colour
		First treated with tannic acid + ferrous sulphate. Then dyed with aloe solution + nitric acid + sodium hydroxide	Cotton	Brown colour was obtained.
		First treated with alum + ferrous sulphate, then dyed with the aloe solution + nitric acid + sodium hydroxide.	Cotton	Ochre-yellow shade was observed.

Table 3: Results of wash fastness

Procedure	Fabric	Change in colour	Staining on white
Aloe leaf solution + concentrated nitric acid	Silk	5	5
	Wool	5	5
Dyeing after cationisation of cotton	Cotton	3	2/3
Aloe solution + nitric acid + common salt + sodium hydroxide.	Cotton	1	3/4
Myrabolan + ferrous sulphate. Then dyed with aloe solution + nitric acid.	Cotton	2	4
Myrabolan + alum. Then dyed with aloe solution + nitric acid + sodium hydroxide	Cotton	3	4
Tannic acid + ferrous sulphate. Then dyed with aloe solution + nitric acid + sodium hydroxide	Cotton	3	2/3
Alum + ferrous sulphate then dyed with the aloe solution + nitric acid + sodium hydroxide.	Cotton	4	4

fastness, no staining was observed on adjacent white sample. Dye on cotton was not as fast as on silk and wool but was very satisfactory.

Conclusion:

In the present study, utility of aloe plant for dyeing of cotton silk and wool was explored. A solution of fresh aloe leaves was used for dyeing of cotton and protein fibres in different shades. When applied with introduction of few drops of nitric acid in aloe leaf solution, it rendered beautiful golden yellow colour on silk and wool. Shades obtained had outstanding wash fastness and colours had improved and deepened after washing. Cotton was dyed by introduction of different mordants or combination of mordants. This again produced a range of colours from yellow, pink, khaki to brown.

It is possible that aloe leaves may contain traces of different other dyes but with the limitation of time the investigator could identify and use it for protein fibres as acid dye and for cotton as mordant dye and hence it may be concluded as acid mordant dye.

This appears to be first novel and unique exploitation of aloe plant for dye application on different natural fibres. The investigators could not optimise the strength. Main emphasis was on obtaining different range of colours.

Eco-friendly aspect of this dye would lead to widespread acceptance of application in use of dyeing cotton, silk and wool. It will not only serve as a dye but offer other health elements like anti microbial properties, detoxifying agent and treatment for various skin disorders.

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