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ANTIBACTERIAL AND FASTNESS PROPERTIES OF *SALVIA OFFICINALIS (L)* OF SILK DYED FABRIC

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ABSTRACT
This present study investigates the extraction of dye pigment from *Salvia officinalis (L)* leaves to dye silk fabric. The aqueous dye extraction method and dyeing was employed by using a standard process and carried out under varying conditions such as pH, duration, temperature and concentration of dye material. In each case the optical density or absorbance value has been estimated using colorimeter. The dyeing behaviour of natural dye extracted from the leaves of *Salvia officinalis (L)* on silk fabric has been investigated the effect of different methods of application of selected mordants like Alum and Myrobolan. Colour values and colour co-ordinates were evaluated. The dyed silk fabrics showed acceptable fastness properties and antibacterial activity against Gram-positive and Gram negative bacteria.

KEYWORDS: Extraction, Dyeing, Mordants, Silk, Antibacterial Activity, *Salvia officinalis (L)*

I. INTRODUCTION
In this century, a global awareness is already in place favouring the use of natural resources for protecting the environment and earth from pollution and ecological imbalances. The present scenario is favoured more towards the utilization of vast diversity of natural resources of colour pigments for their use in food materials, pharmaceuticals and textiles in place of their synthetic counterparts. (1)

Natural dyes are aesthetically appealing, environment friendly, bio degradable, non-toxic and cost effective in nature. Growing interest for naturally dyed products among foreign and domestic buyers with the world becoming more conscious towards ecology and environment. There is greater need today to revive our heritage and tradition of natural dyeing of silk particularly used in handloom industries. (2, 3)

The demand for eco-friendly product is always growing throughout the world. The present trend for utilization of synthetic dyes in the textile industry is switching over towards the use of naturally occurring colorants. The use of natural dyes can play role in minimizing pollution and risk to human health. (4) As compared to their synthetic counterparts, these dyes are easily biodegradable and highly compatible with the environment. (5)

Salvia officinalis (L) a shrub with aromatic leaves and commonly cultivated in gardens throughout India. It is a native plant of East Mediterranean region, which has Medicinal value: The leaves are known for its antiseptic, wound healing properties (6) and are widely used in folk medicine. (7) Potential therapeutic activities of these Salvia species are due to their essential oils (8), since these species are known to possess antioxidant, antimicrobial, antifungal, and aromatic properties along with colouring pigments. (9)

Ayurvastra existed as a branch of Ayurveda, the 5000-year-old system of medicine from India. It represents a modality of healing and achieving wellness and also a complex system or technique of dyeing clothing using medicinal plants and herbs. India is famous in Ayurvastra dyeing textiles with consisting of Antibacterial properties. Skin has the ability to absorb germs and chemicals which are present in the environment similarly, it has ability to absorb dye compounds found in our natural dyes. These herbs release their medicinal qualities into the body and strengthen the skin's ability to block and resist harmful substances. [6]

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In order to natural dyes to be used successfully on commercial scale, there is a need to properly adopt the suitable and standardized techniques. This can be accomplished through scientific knowledge on compatibility checking of selective natural dyes, standardization of dyeing methods, essential variables in dyeing bath and kinetics of dyeing. Regarding all these factors, information available in the literature is not clear and sufficient for natural dyes. (10) Hence the present work aims at studying the potential of dyeing silk fabric using leaves extracts of Salvia officinalis (L), natural dye using mordants like alum and myrobalan. The research has focused on investigating the fastness and antibacterial properties of silk dyed fabrics.

II. MATERIALS AND METHODS

Selection of raw material

Fresh leaves of *Salvia officinalis (L)* were collected at Gandhi Krishi Vignan Kendra (GKVK), Bengaluru, Karnataka. The leaves were thoroughly washed and dried at room temperature. The dried leaves were macerated to fine powder.

Plain woven bleached mulberry silk fabric GSM 57, with a yarn density of 108 EPI and 106 PPI were selected for dyeing.

Dye extraction method

1 gram of the macerated material was taken and cooked in distilled water with MLR 1:40 was optimized by using varying at alkali conditions namely, 0.02µg (pH-4), 0.04µg (pH-5), 0.06µg (pH-6), 0.08µg (pH-7), 0.10µg (pH-8), 0.15µg (pH-9), 0.20µg (pH-10) and duration for 30, 45, 60, 75, 90 to 120 minutes, the temperature ranged from 30ºC, 40ºC, 50ºC 60ºC, 70ºC, 80ºC, 98ºC to 100ºC. The resultant dye solution was then filtered and diluted to 1:5 in distilled water for suitable received concentrations to measure the absorbance of the solution to optimize the alkali concentration, temperature and duration for extraction of the dye. The extracted dye was cooled and the dye extracts was filtered using a filter paper to separate the solution from the residue was filtered and evaporated using an oven at 40ºC for drying and the dried dye powder obtained were used for dyeing.

Dyeing of Silk fabrics

Plain woven bleached mulberry silk fabric GSM 57, with a yarn density of 108 EPI and 106 PPI were selected for dyeing. Dyeing was carried out at optimum conditions for pH ranging from 5,6,7,8,9 and 10, temperature varying from 30ºC, 40ºC, 50ºC 60ºC, 70ºC, 80ºC, 98ºC to 100ºC, duration 30,45,60,75 to 90 minutes and dye concentration ranging 5,10,15,20,30,40 and 50%. Complete dyeing process was carried out at dye bath maintained at optimum pH, temperature, duration and dye shade percentage at MLR 1:40 in a beaker dyeing machine. The dyed samples were subsequently soaped in 2 gpl non-ionic detergent at 60oC for 15 minutes and washed with water and dried at room temperature.

Mordanting method

The substrates were mordanted using 10% (owf) solution each of potassium aluminum sulfate a metallic mordant and myrobalan a bio mordant employed with MLR 1:20 for 30minutes at 60ºC. The samples were later rinsed in water and dried. The silk fabric dyed without mordant constituted the control. All three mordanting methods, employed like Pre mordanting, was carried out before dyeing in aqueous solution of the mordant. All the mordanted fabrics were then separately dyed. In the Simultaneous mordanting method (i.e., dyeing along with mordants) was followed at 90ºC, the fabric was immersed in a bath containing a mordant and dye extract for 60 minutes. The dyed fabrics were rinsed with water, soaped with non-ionic detergent at 60ºC for 15 minutes and washed with water squeezed and dried in shade. Post mordanting was carried out by taking the dyed silk fabric at 60ºC for 30minutes after mordanting the sample was rinsed with water and soaped with non-ionic soap solution for 60ºC for 15 minutes, washed with water, squeezed and dried.

Absorbance and Colour Strength Measurements

Dyeing was carried out at different dye concentrations like 5%, 10%, 15%, 20%, 30%, 40% and 50% were prepared from the crude extract by maintaining material-to-liquor (MLR) ratio at 1:40. The absorbance of the dye solution was recorded before and after dyeing process with colorimeter at filter number 43 to record the absorbance values for silk fabrics. The percentage of dye uptake was calculated using the following formula.

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$$\% \text{ Dye uptake} = \frac{\text{Absorption before dyeing} - \text{Absorption after dyeing}}{\textit{Absorption before dyeing}} \text{X100} \quad (1)$$

Measurement of colour strength and Colour values

Colour was been evaluated by means of K/S and CIELAB colour difference values with illuminant D 65/10 observer on Greatag Macbeth Colour Eye 7000 A Spectro-photometer. Five measurements were made for each sample and the variation in percentage reflectance values at a range of 360 nm was recorded. The K/S values were assessed using the Kubelka-Munk equation.

$$K/S = \frac{(1-R)^2}{2R} \quad (2)$$

Where, R is the observed reflectance, K, the absorption co-efficient and S, the light scattering coefficient.

Assessment of colour strength and fastness properties

Dyed samples were evaluated for the colour strength and the colour fastness to washing, rubbing and perspiration. Colour fastness rating was determined as per the standard methods like Washing (ISO: 105:CO2), rubbing (ISO: 105x-12) and perspiration (ISO: 105:E04).

Antimicrobial activity

Test organisms: cultures of the following micro-organisms were used in this study Escherichia coli a gram negative bacteria and S. aureus a gram positive bacteria. E. coli were selected for its resistance to common antimicrobial agents and S. aureus is the major cause for cross infection and it is the most frequently evaluated species by AATCC Test Method 147-2001, using qualitative analysis by parallel streak method antimicrobial activity were evaluated.

Using parallel streak method, antibacterial activity against Gram-positive and Gram negative bacteria were tested using treated and untreated samples were placed in intimate contact with bacteriostasis agar, which has been previously streaked with an inoculum of test organisms. After incubation, a streak of interrupted growth underneath and along the side of the test material indicates effectiveness of the fabric. The antibacterial assay plates were incubated at 37°C for 24 hrs. The diameters of the inhibition zones were measured in mm.

III. RESULTS AND DISCUSSION

Effect of dye extraction conditions on Dye yield

Based on the evaluation it was observed variations in optical density with respect to different medium of dye extraction were carried at acidic, neutral and alkaline medium. The colour component in acidic condition was lesser than the component extracted from neutral and alkali medium. Therefore, the dye extraction was optimized by using varying alkali concentration, the maximum optical density value 0.25 showed a gradual increase with the increase in concentration 0.20µg of alkali (sodium carbonate) was recorded at pH 10, as shown in Figure:1 was considered as optimum concentration for extraction of the dye from the leaves of *Salvia officinalis (L)* and there was increase in the dye yield and further increase in the alkalinity results in decrease in the optical density values were not found to be significant. Since most of the natural dyes contain hydroxyl groups which are soluble in alkaline solution. (3,4)

The dye extraction was carried out for different temperatures and maximum dye yield was recorded at 90ºC reveals with a maximum value of optical density 0.59 (Fig-3) and further increase in the temperature resulted in decreased optical density. Extraction was carried out for different duration of time for maximum value of optical density 0.42 was recorded at 90 minutes, but the rate of further increase in duration decreased after 120 minutes of extraction (Fig-2). After reaching the saturation period the dye yield decreases because there is no significant difference on factors like pH, temperature and duration. Extraction for longer periods did not help in increasing the dye yield. This may be because after particular time substances other than the dye start to leach out from the plant material, which may hinder the dye absorption. (5,6) Dye yield was found to be maximum for optimum pH 10 (for alkali concentration 0.20µg sodium carbonate), temperature 90ºC and duration 90 minutes was 24% and pH is 9 which shows that dye is towards alkaline side.

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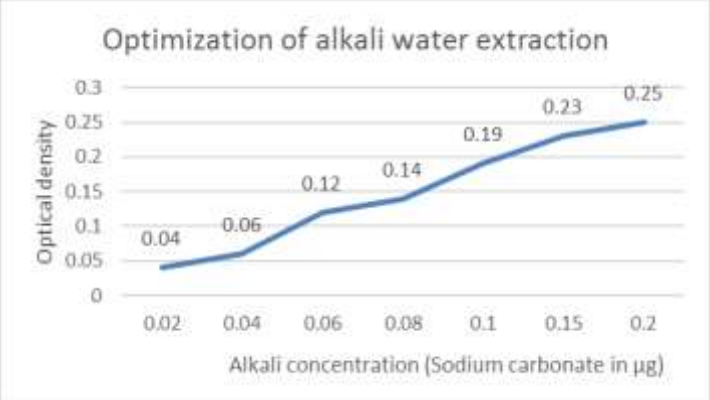
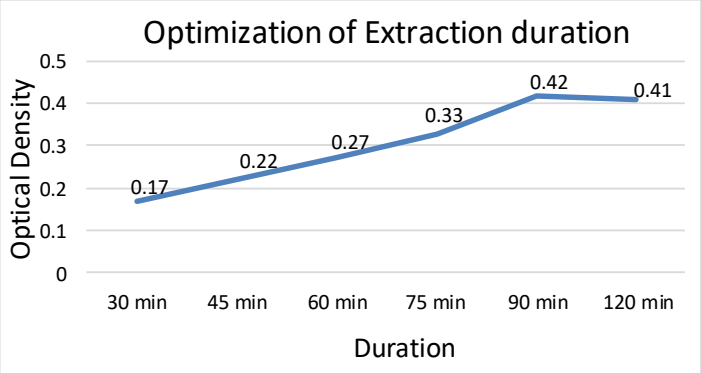
Figure: 1



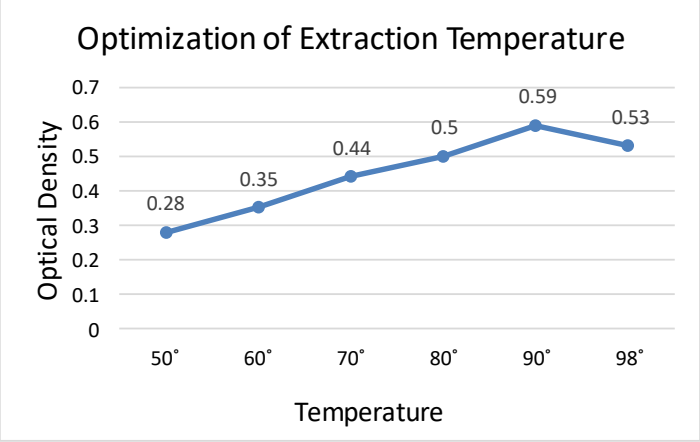
Effect of pH on dye extraction

Figure: 2



Effect of duration on dye extraction

Figure: 3



Effect of temperature on dye extraction

Effect of Dyeing conditions on dye uptake

When silk fabric dyed with varying pH, after reaching saturated point the dye uptake value declined with the increase in the pH of the dye bath which has considerable effect on the dyeability of silk fabric(Figure-4). Therefore, maximum dye uptake value expressed in terms of percentage, dye uptake 91 was recorded at pH 4

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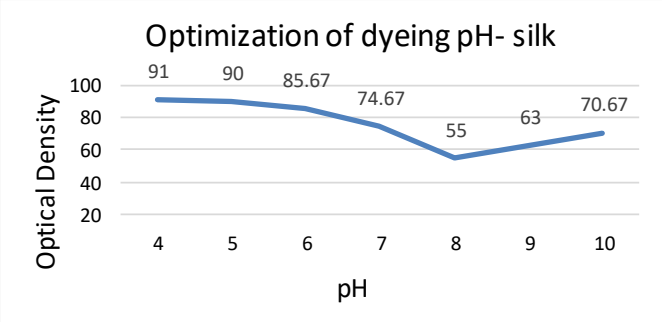
was taken as optimum for dyeing silk fabric with the leaf extracts of Salvia officinalis. The effect of the dye bath on pH can be attributed to the correlation between dye and silk fibres. Since the dye used is a water soluble containing anionic groups, it would interact ionically with the protonated terminal amino groups of silk fibers at acidic pH via ion-exchange reaction. (11)

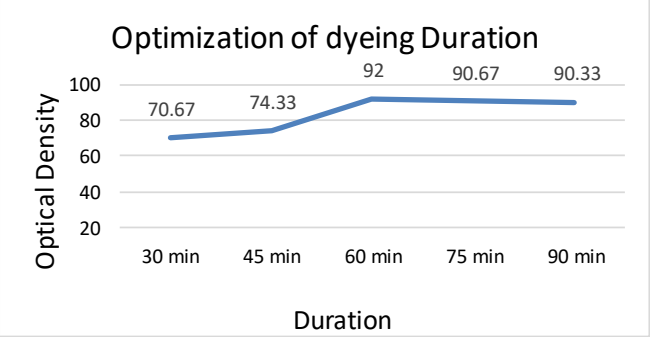
Figure-6 reveals the dye uptake showed a gradual increase with the increase in temperature from 50-70ºC for silk maximum dye uptake 93.67 was recorded at 70ºC. The gradual increase in the dye uptake was observed with increase in the duration up to 60 minutes for the maximum dye uptake 92 was noticed, for which further increase showed a decline in the dye uptake. Longer dyeing time means higher color strength until dye exhaustion attains equilibrium. (12) The maximum dye yield was recorded at duration of 60 min (Figure-5), the dye concentration for 20% gave better dye uptake when compared with other varying concentration (Figure-7). Optical density of the dye solution will decrease with the increase in the dye uptake on the fabric.

Figure: 4



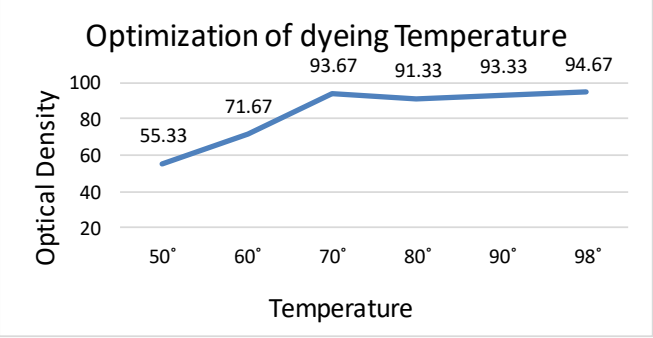
Effect of pH on dyeing

Figure: 5



Effect of duration on dyeing

Figure: 6



Effect of temperature on dyeing

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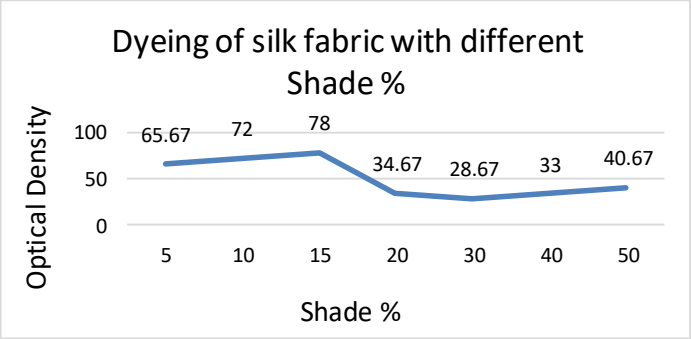
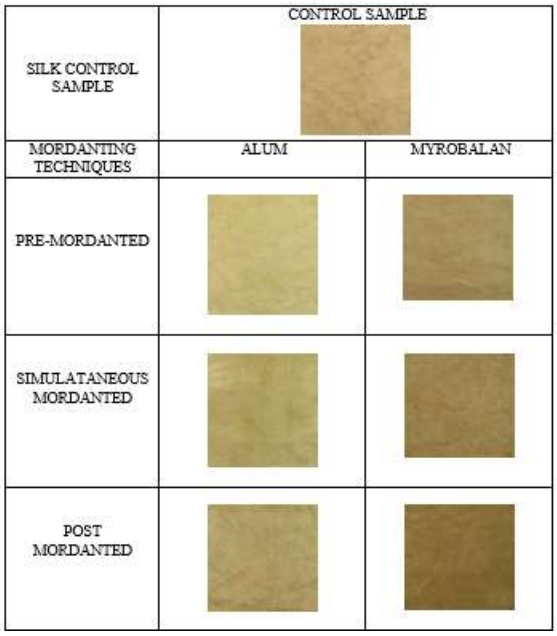
Figure: 7



Effect of shade on dyeing

Figure: 8



Dyed Silk Samples of Salvia officinalis (L)

Dye Concentration 20% and Mordant 10%

Colour values and fastness properties

Dyed samples were evaluated for the colour strength, fastness to washing, rubbing, and perspiration fastness.

Table 1. K/S and colour co-ordinates of silk samples dyed with (20%) *Salvia officinalis (L) dye*

Sl. No.	Mordants	Mordanting Method	K/S	L	a*	b*	C	h
1.	Control		3.59	66.16	4.97	17.31	18.04	74.03
2.	Alum (10%)	Pre	2.59	74.58	2.9	21.21	21.42	82.24
3.		Meta	3.79	71.53	3.81	22.12	22.44	80.22
4.		Post	3.65	67.35	4.35	22.08	22.54	78.81

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5.	Myrobolan (10%)	Pre	5.15	62.28	5.11	19.86	20.52	75.56
6.		Meta	5.68	61.77	5.76	21.93	22.75	74.97
7.		Post	6.09	63.38	5.45	23.4	23.98	76.91

The table 1 shows the K/S values and colour co-ordinates of silk samples dyed with *Salvia officinalis (L)* extracts. The K/S values of the mordanted samples were found to be higher (6.09) in post mordanting method than the unmordanted sample (control-3.59) except alum pre-mordanted samples. The K/S values improved considerably with control to myrobolan when compared to alum. The unmordanted silk sample found to have a K/S value 3.59 and other mordanted samples were observed in the range of 2.59 to 6.09. Between techniques only myrobalan post mordanted samples showed a significant change in k/s values when compared with control and alum dyed samples.

Silk samples treated with alum (pre and post mordanting) showed decreased k/s values when compared to simultaneous mordanted samples showed increased k/s value of 3.79. Post mordanting samples treated with myrobalan showed maximum 6.09 k/s values with 20% dye concentration. The unmordanted silk fabric produce peach puff, whereas mordanted samples resulted in tan, wheat, bisque and peach puff shades. The use of mordants in dyeing of silk fabrics resulted in different shades of colours for all techniques. Mordanting certainly has influenced the colour values of the dyed samples, increasing the k/s values in myrolaban mordanted samples, whereas alum mordanting samples showed the reduced the colour strength. Whereas mordanting with alum has resulted in lowering the dye uptake. (13) There is a significant difference in mordants and mordanting methods, over all myrobalon mordanted samples gave better dye shade and k/s values when compared to control and alum mordanted samples.

The dyed samples exhibited good fastness property towards washing, rubbing and perspiration on silk dyed samples ranged (3-5).

Table 2. Fastness properties of silk samples dyed with *Salvia officinalis (L)* dye

Sl. No.	Mordants	Mordanting Method	Wash fastness		Perspiration fastness				Rubbing fastness	
			Colour change	Colour stain	Acidic		Alkaline		Dry	Wet
					Colour change	Colour stain	Colour change	Colour stain		
1.	Control		4	5	4	5	4	5	5	4-5
2.	Alum	Pre	4	5	3-4	5	4	5	4-5	4-5
3.		Meta	4	5	4	5	4	5	5	4-5
4.		Post	4	5	4	5	4	5	5	4-5
5.	Myrobolan	Pre	4-5	5	3-4	5	4	5	4-5	4
6.		Meta	5	5	4-5	5	4	5	5	4
7.		Post	4	5	4	5	4	5	4	5

The table 2 shows fastness properties of silk samples dyed with Salvia officinalis (L) extract, the unmordanted control sample showed a gray scale rating of 4-5 for change in colour and stain respectively to wash fastness. There is negligible stain in the washing for all the samples. A slight improvement in the pre–mordanting myrobolan treated sample which showed excellent wash fastness. Perspiration fastness of alkaline treated fabrics were found to be 4-5 and 4 for colour change. Staining was negligible with all the mordants and with its techniques. All the samples were found to be in the range of moderate to excellent 3-5 in both acidic and conditions. The control sample were ranged from 5 and 4-5 for dry and wet respectively and no improvement in fastness to rubbing was noticed with respect to change in stain with different mordanting techniques.

Antimicrobial activity of Dyed fabrics

The silk fabrics dyed with *Salvia officinalis (L)* were tested against pathogens namely S. aureus and E. coli. Undyed silk samples were taken as negative control sample. Many metabolites extracted from the seed were

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identified as thujone, camphor, humulene, which possess the antimicrobial activity. (14) The control sample of silk fabric did not show inhibition against pathogens, whereas dyed silk fabric showed resistant to Staphylococcus aureus and E coli pathogens.

Table 4. Antimicrobial properties of the dyed fabric

Sl. No.	Particulars	Fabric	Zone of inhibition in mm	
			Staphylococcus aureus	*E coli*
1	Control fabric		-	-
2	Dyed fabric	Silk	2 mm	1 mm

'-'= no inhibition

IV. CONCLUSION

Natural colourant were extracted from the leaves of *Salvia officinalis (L)* which are the renewable sources and silk fabrics dyed with plant extracts showed good colour strength value and exhibited satisfactory to good fastness properties with respect to washing, rubbing and perspiration. Silk fabric dyed with these extracts when investigated for antimicrobial activity, the dyed fabric is found to possess resistance to pathogens like *Staphylococcus aureus* and *Escherichia coli.*

A large quantity of leaves goes unused and it is cheap source of raw material for dye extraction purpose. The extraction process of dye is also very simple and economical. Using of different mordants and mordanting methods produce different colours and shades. Since there is demand for natural dyed products in niche market. The leaves of *Salvia officinalis (L)* consists of antimicrobial agents which inhibits the microbial growth. Therefore, the fabric dyed with pigments of *Salvia officinalis* (L) can be used as a potential dye source for medical textiles and it will be very useful for dyeing silk fabrics

V. REFERENCES

[1] A. Stammati, P. Bonsi, F. Zucco, R. Moezelaar, H. L. Alakomi, A.Von Wright, "Toxicity of Selected Plant Volatiles in Microbial and Mammalian Short-term Assay", Food and Chem. Vol. 37, pp. 813-823 1999.
[2] M. L. Gulrajani, and D. Gupta, "Present Status of Natural Dyes, Convention of Natural Dyes", Indian Institute of Technology, Delhi, pp. 3-22, 1999.
[3] U. M. Sewekow, "Natural dyes- an alternate to synthetic dyes", Mellianad Textilberichte, Vol. 69, no. 4, pp.145-148, 1998.
[4] S. Ali, T. Hussain and R. Nawaz, "Optimization of alkaline extraction of natural dye from Henna leaves and it's dyeing on cotton by exhaust method", Journal of cleaner production, Vol. 17, No. 1, pp. 61-66, 2000.
[5] E. Zarkogianni, E. Mikropoulou, E. Varella & E. Tsatsaroni, "Colour and Fastness of Natural Dyes: Revival of Traditional Dyeing Techniques", J.S.D.C., Coloration Technology, Vol. 127, No. 1, pp. 18-27, 2010.
[6] The Wealth of India – A Dictionary of Indian Raw Materials and Industrial Products, Council of Scientific Research and Industrial Research, National Institute of Science Communication and Information Resources, New Delhi, Vol. IX, pp. 196-197, 1972.
[7] G. Penso, Index Plantarum Medicinalium Totius Mundi Eorumque Synonymorum, OEMF, Milano, Italy, 1983.
[8] A. Y. Leung and S. Foster, Encyclopedia of Common Natural Ingredients Used in Food, Drugs and Cosmetics, John Wiley & Sons, 2nd edition, New York, USA, 1996.
[9] T. A. Al-Howiriny, "Chemical composition and antimicrobial activity of essential oil of Salvia verbenaca", Biotechnology, Vol. 1, pp. 45–48. 2002.
[10] A.S. Samanta & P. Agarwal, "Application of Natural dyes on textiles", Indian Journal of Fibre & Textile Research, Vol. 34, pp. 348-399, 2009.
[11] H. F. Mansour and A. A. Haroun, "Ultrasonic efficiency on the photo fading of madder dyed silk using egg albumen and aluminium ions chelating", In: The 6th International conference of textile research division, Cairo, Egypt: National Research Centre, pp. 15–67, 2009.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

[12] F. A. Nagia, and EL-Mohamedi, "Dyeing properties of natural dyes extracted from turmeric and their comparison with reactive dyeing", Dyes and Pigments, Vol. 75, No. 3, pp. 550–555, 2006.
[13] K. N. Ninge Gowda, Naveen V Padaki, Shillin Sangappa, S. N. Mishra, R. Sudhakar and Raji Munshi, "Natural Black dye from the nuts of Semecarpus anacardium", Asian Dyer, Vol. 7, No. 4, pp. 50-52 2010.
[14] Porte, Godoy, Chemical composition of sage *(Salvia officinalis L.)*, Rev. Bras. Pl. Med., Campinas, v.15, n.3, p.438-441, 2013.

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