BUSITEMA UNIVERSITY
*Pursuing Excellence*

# FACULTY OF ENGINEERING
# DEPARTMENT OF TEXTILE AND GINNING
# FINAL YEAR PROJECT REPORT

## NATURAL DYE FROM HARUNGANA MADAGASCARIENSIS STEM BARK, EFFICIENT EXTRACTION AND APPLICATION ON PLAIN WOVEN SILK AND COTTON FABRICS

**BY**


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## ABSTRACT

Nowadays, textile products have found a wide range of application in apparel, domestic and industrial area. Consumers are increasingly considering the sustainability of their purchases as they gain access to an array of attractive fabrics. Increasing awareness about safe products in textiles has developed the worldwide choice of natural colour based textile. For the present study Harungana Madagascariensis has been selected as source of natural dye.

The color of the fabrics was investigated in terms of fastness properties against light, washing and rubbing. To enhance the textile designer using an eco-design approach while using natural textile with natural colour, this study developed an environmentally friendly dyeing process and good fastness properties.

## DECLARATION

I Namiiro Moureen, declare that this dissertation is my original work whose composition has never been presented to any institution for a similar award.

Date..24th May 2018...

Signature.....................

## APPROVAL

I hereby submit in this research report project with permission from the following supervisors;

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SIGN…………………… DATE…………………

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SIGN…………………… DATE……………………

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Special thanks go to Mr. Nibikora the head of department textile and ginning for the support rendered to me during the entire project research.

**DEDICATION.**

I dedicate this report to my dear mums Ms. Nakiyini Nambiro Ritah and Ms. Busingye Esther for all the necessary support they provide to me. Not forgetting my beloved brothers, sisters and dear friends.

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# CHAPTER ONE: INTRODUCTION

## 1.1 Background

Traditionally, plants in Uganda have been utilized as a source of colorants in the making of mats, ropes and other home-based craft materials for a long time. Natural dyes derived from plants have recently gained economic advantage over synthetic dyes because of their non-toxic, non-carcinogenic and biodegradable nature(Kumar & Agarwal, 2009). They are environmentally friendly making them a top priority for use in the textile industry(Wanyama, Kiremire, Ogwok, & Murumu, 2011), with a growing need to find suitable and less toxic alternative sources of natural dyes(Wanyama et al., 2011). Various researches have shown that dyes from plants generally possess desirable color properties and good performance on natural fibres which are comparable to some highly rated synthetic dyes(Kulkarni, Gokhale, Bodake, & Pathade, 2011).

Textile materials used to be colored for value addition, look and desire of the customers. Anciently, this purpose of coloring textile was initiated using colors of natural source, until synthetic colors/dyes were invented and commercialized.

For ready availability of pure synthetic dyes of different types/classes and its cost advantages, most of textile dyers/ manufacturers shifted towards use of synthetic colorant.

Almost all the synthetic colorants being synthesized from petrochemical sources through hazardous chemical processes poses threat towards its eco-friendliness.(Samanta & Konar, 2011).

Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources roots, berries, bark, leaves, wood and other biological sources such as fungi and lichens. Natural dyes are known for their use in coloring of food substrate, leather, wood as well as natural fibers like wool, silk, cotton and flax as major areas of application since ancient times. (Saravanan, Chandramohan, Saivaraj, & Deepa, 2013). Natural dyes are related with cultural practices, rituals, arts and crafts, fabrics and for the satisfaction of personal embodiment. However, dye yielding plants have not received significant attention. Recently, interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries and preferred because they are non-allergic, non-carcinogenic and have lower toxicity and better biodegradability than the synthetic dyes (M. Macieiral & 1, 2013).

Synthetic dyes are man-made. These dyes are made from petroleum, sometimes in combination with mineral-derived components. The first human-made organic aniline dye, mauveine, was discovered by William Henry Perkin in 1856.(Nagendrappa, 2010)(Katz A., 2003)

Harungana Madagascariensis; English name dragon's blood tree, local names include; mulilira in Luganda, munianga in rukiga and mutaha in runyankore. It belongs to kingdom plantae, order malpighiales, family hypericaceae, genus Harungana and species H.Madagascariensis. It can be found in medium to low altitudes in evergreen forest, usually around the forest margins and along river banks. It is widely distributed from South Africa to Sudan. It is often the first plant species to exist in a forest that has been cleared. "H. madagascariensis" can be found in both forest and savanna regions. It is native to Central African Republic, Congo, Democratic Republic of Congo, Ethiopia, Kenya, Lesotho, Madagascar, Namibia, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania and Uganda.(Sichilongo, 2015).

## 1.2 Problem statement

The use of synthetic dyes has been a cause of concern, for ecological and health reasons. They are suspected to release harmful chemicals that are allergic, carcinogenic and detrimental to human health. This is because they use caustic soda, hydros (Sodium hydrosulphite), nitric acid for mordanting which expose the workers who are engaged in dyeing to various health hazards. On the other hand, natural dyes are environment-friendly and possess no threat to human health. Uganda has a rich source of native plants from which natural dyes can be extracted. These can act as an alternative for synthetic dyes. A large plant resource base for natural dyes exists in Uganda but remains in the wild and largely unexploited and Harungana madagascariensis was among the identified plants.

## 1.3 Objectives

### 1.3.1 Main objective

To evaluate the dyeing potential of dye extracts from Harungana madagascariensis stem bark on plain woven silk and cotton fabrics.

### 1.3.2 Specific objectives

To extract dye from the stem bark of Harungana madagascariensis using the best solvent system with the highest absorbance value.

To dye plain woven silk and cotton fabrics with the extracts using ALUM mordant.

To determine color strength, fastness to; washing, rubbing and light.

## 1.4 Justification

Currently world over there is a concern about environmental issues and some laws are focused on preserving it. This means that some industrial procedures must be redesigned and the ancestral ones can be reconsidered as a valuable alternative to these days' processes. The textile sector is one of those which has pollutant processes and one of the most related is the wet process, mainly dyeing and printing.

Synthetic dyes tend to remain quite stable to common oxidation and reduction processes as per the designing and so are very difficult to remove from the textile industry effluents. Natural dyes are biodegradable without the use of any oxidant or reductant.

Synthetic dyes, if at all are degraded, are full of byproducts that are directly or indirectly proven to be health hazards, such hazardous compounds have so far not been detected in the natural dye degraded byproducts(Sathianarayanan & Narendra, 2012).

Different natural dyes are considered in order to replace the ones used currently as they are regarded as pollutants. Natural resources are seriously considered as the alternative for a friendly environmentally dyes process. This research will further enhance the growth of interest in natural dyes and dye-yielding plants for textile application.

### 1.5 Scope

In the evaluation of natural dyes from Harungana madagascariensis, the research will concentrate on extracting dyes from the stem of this shrub, dyeing of plain woven silk and cotton fabrics with the extracts using ALUM (Aluminium Potassium Sulphate) mordant by post mordanting method and analyzing the results from color strength the wash, rubbing and light fastness tests for this dye. This will be done from the Southern Range Nyanza Limited laboratory in Njeru town.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Natural fibers

Natural fibre encompasses all forms of fibres from woody plants, grasses, fruits, agriculture crops, seeds, water plants, palms, wild plants, leaves, animal feathers, and animal skins. By-products of pineapple, banana, rice, sugarcane, coconut, oil palm, hemp, cotton, abaca, sugar palm, sisal, jute and bamboo are among the fibres known to be used to make composites. Wool and silk are strong fibrous materials and wool had been used in textile industry dated back from 35,000 years ago and silk from at least 5,000 years.(Salit, 2014)

### 2.2 Cotton fiber

Cotton is a soft, fluffy staple fiber that grows in a boll, or protective case, around the seeds of the cotton plants of the genus Gossypium in the mallow family Malvaceae. Under natural conditions, the cotton bolls will increase the dispersal of the seeds.(Shore, 2002). It is composed basically of a substance called cellulose. As cotton occupies 50% of the consumption of fibres by weight in the world it is called as the king of all fibres. Cotton is the fabric for every home and is the most widely produced of textile fabrics today. The fiber is hollow in the center and is convoluted to give its quality of versatility, appearance, performance and above all, its natural comfort. Cotton fibers take dye easily and have good color retention ability. (Shore, 2002). It has good physical and chemical properties which are required for better processing in spinning, weaving, knitting, dyeing, printing and finishing. The physical properties include strength, color, elongation at break, moisture regain, effect of heat, elastic recovery, effect of age and the chemical properties include effect of acids, effect of alkalis, effect of insects and microorganisms.

### 2.3 Silk

Silk is a natural protein fiber, some forms of which can be woven into textiles. The protein fiber of silk is composed mainly of fibroin and is produced by certain insect larvae to form cocoons. The best-known silk is obtained from the cocoons of the larvae of the mulberry silkworm Bombyx mori reared in captivity (sericulture). The shimmering appearance of silk is due to the triangular prism-like structure of the silk fibre, which allows silk cloth to refract incoming light at different angles, thus producing different colors.(Broadbent, 2001)

Silk is produced by several insects, but generally only the silk of moth caterpillars has been used for textile manufacturing. There has been some research into other types of silk, which differ at the molecular level. Silk is mainly produced by the larvae of insects undergoing complete metamorphosis, but some insects such as web spinners and raspy crickets produce silk throughout. In Uganda, silk farming is a practice that has been embraced by the local farmers in the Central, Western and Eastern parts of the country. Silk is the strongest natural fibre produced by silkworms when they are making cocoons. It is a protein fiber secreted by glands (often located near the mouth) of insects during the preparation of cocoons. Silk has inherent affinity for dyes, vibrant colors and has high absorbent qualities. It is evident that natural dyes from the leaves of coffee and mulberry can effectively be used for dyeing silk fabrics. (Fabrics, Mordants, Janani, & Winifred, 2013).

### 2.4 Dyes

A dye is a colored substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution, and may require a mordant to improve the fastness of the dye on the fiber.(Gürses, Açıkyıldız, Güneş, & Gürses, 2016). They absorb and reflect color at specific wavelengths to give human eyes a sense of color. The wavelength of the absorbed light able to excite an electron from an occupied orbital to the first unoccupied molecular orbital then corresponds to visible light. The smaller the energy difference, the longer the wavelength of the light absorbed, according to the Planck equation:

$$\Delta E = h\nu = \frac{hc}{\lambda}$$

In this equation, $\Delta E$ is the energy difference between the implicated molecular orbitals, h is Planck's constant, v is the frequency and c is the speed of the absorbed light, and $\lambda$ is its wavelength.(Broadbent, 2001)

#### 2.4.1 Classifications of Dyes

Colorants are classified in various ways broadly depending on chemical functional groups (Structure), method of application, Hue and Ionic character. Based on structure they include indigoids, anthraquinones, alpha napthoquinones, flavones, carotenoids while for hue it depends on lightness, darkness or strength. For method of application they include; vat dyes, mordant, direct, disperse, acid and basic dyes.(Samanta & Konar, 2011)

### 2.4.2 Natural dyes

Natural dyes cover all the dyes derived from the natural sources like plants, animals and minerals. Natural dyes are mostly non-substantive and must be applied on textiles by the help of mordants, usually a metallic salt, having an affinity for both the coloring matter and the fibre. These metallic mordants after combining with dye in the fibre, it forms an insoluble precipitate or lake and thus both the dye and mordant get fixed to become wash fast to a reasonable level.(Saxena & Raja, 2015)

### 2.4.3 Use of natural dyes on fabrics

- The shades produced by natural dyes/colorants are usually soft and soothing to the human eye.
- Natural dyestuffs produce rare color ideas and are automatically harmonizing.
- Some of its constituents are anti-allergens, hence prove safe for skin contact and are mostly non-hazardous to human health.
- Natural dyes are usually moth proof and can replace synthetic dyes in kid's garments and food-stuffs for safety.

### 2.4.4 Disadvantages of natural dyes

- Natural dyeing requires skilled workmanship and is therefore expensive.
- Nearly all-natural dyes with a few exceptions require the use of mordants to fix them on to the textile substrate.
- Scientific backup of a large part of the science involved in natural dyeing is still need to be explored.

### 2.4.5 Extraction methods of natural dyes

Natural Dyes cannot be used directly from their renewable sources. Using raw materials for dyeing has many limitations. Safe and cheap extraction of main coloring component is most important without affecting the extraction conditions and avoiding any contamination in various extraction techniques. Several extraction methodologies for natural dye that comply with both consumer preference and regulatory control and that are cost effective are becoming more popular(Prabhu & Bhute, 2012). Some of the techniques of extractions of natural dyes are;

- Simple Aqueous Methods
- Complicated Solvent Systems
- Supercritical Fluid Extraction
- Ultrasonic Extraction

### 2.5 Application on cotton and silk

Mainly color is applied to cotton and fabrics by dyeing or printing.

#### 2.5.1 Dyeing

Dyeing is the uniform coloration of the mass of fibres constituting the material, usually to match a pre-specified color. (Samanta & Konar, 2011)

Types of dyeing systems include;

Aqueous - in water

Non-aqueous - in organic solvents

Sublimation - thermosal, heat transfer.

Coloration of a textile material is achieved in a number of different ways:

- Direct dyeing, in which the dye in the aqueous solution in contact with the material is gradually absorbed into the fibres because of its inherent substantivity;
- Dyeing with a soluble precursor of the dye, which forms an insoluble pigment deep within the fibres on treatment after dyeing;
- Direct dyeing followed by chemical reaction of the dye with appropriate groups in the fibre;
- Adhesion of the dye or pigment to the surface of the fibres using an appropriate binder.

#### 2.5.2 Dyeing of cotton

Cotton is a cellulosic fibre. The most commonly used dyes for cotton are reactive dyes, direct dyes, vat dyes and sulphur dyes. The reactive dyes form covalent bond with hydroxyl groups of cotton fibre. Acid dyes and cationic dyes lack affinity for the cotton fabric and only surface deposition occurs due to the ionic attraction. Natural dyes can be fixed on cotton with the help of natural or metallic mordant.(Katz A., 2003)

### 2.5.3 Dyeing of silk

Silk is more receptive towards mordants. This is due to its amphoteric nature it can absorb acids and bases equally and effectively. When silk is treated with a metallic salts it hydrolyses the salt into an acidic and a basic component. The basic component is absorbed at the –COOH groups and the acidic component is removed during washing. (Katz A., 2003)

## 2.6 Mordants

A mordant is a chemical which can itself be fixed on the fibre and also forms a chemical bond with the natural colorants. It helps in absorption and fixation of natural dyes and also prevents bleeding and fading of colors i.e., improves the fastness properties of the dyed fabrics.(Prabhu & Bhute, 2012)

### 2.6.1 Classification of mordants

There are three types of mordants namely Metal salts or Metallic mordants, tannic acid (Tannins) and Oil mordants.

#### 2.6.1.1 Metal Salts or Metallic Mordants

Metal salts of Aluminium, chromium, iron, copper and tin are used. Some of the common mordants used are Alum, Copper sulphate, ferrous sulphate, Potassium dichromate, Stannous Chloride and Stannic Chloride. Based on the final color produced with the natural dyes, these metallic mordants are further divided in to two types i.e., Brightening Mordants and Dulling Mordants. Alum, Potassium dichromate and Tin (Stannous chloride) falls under the category of brightening mordants and Copper sulphate and Ferrous sulphates are dulling mordants.

#### 2.6.1.2 Tannins

Tannin is an astringent vegetable product found in a wide variety of plants. Plant parts include bark, wood, fruit, fruit pods, leaves, roots and plant galls. Tannin is defined as naturally occurring water soluble polyphenolic compounds of high molecular weight (about 500-3000) containing phenolic hydroxyl groups to enable them to form effective crosslink between proteins and other macromolecules.

They are divided structurally into two distinct classes depending on the type of phenolic nuclei involved and the way they are joined. The first class is referred to as hydrolysable tannins while the other class is termed as condensed tannins.

#### 2.6.1.3 Oil-mordants

Oil mordants are used mainly in dyeing of Turkey red color from madder. The main function of the oil mordants is to form a complex with alum used as the main mordant. Since alum is soluble in water and has no affinity for cotton, it is easily washed out from the treated fabric. The natural occurring oil contains fatty acid such as palmetic, Stearic, oleic etc., and their glycerides.

### 2.6.2 Methods of mordanting

Mordanting can be achieved by pre-mordanting (before dyeing), simultaneously mordanting and dyeing or it may be a post mordanting system (after dyeing).

#### 2.6.2.1 Pre-mordanting method

The textile substrate is first treated in aqueous solution of mordant for optimized time (e.g. 30 - 60 minutes) and temperature (e.g. 70 – 100 °C) with a ML ratio of 1:5 to 1:20 and then dried with or without washing. The mordanted textile material is then dyed following optimized dyeing conditions may be required as salt, soda ash or acid depending on type of textile material and type of natural dye. After dyeing, the textile material is washed properly and soaping is carried out by 2 g/L industrial soap solution as described in standard method of AATCC method 66-2008.

#### 2.6.2.2 Simultaneous mordanting

The textile substrate is immersed in a dye bath solution containing both mordant and dye in a definite quantity and dyeing may be started at the pre-determined optimum condition. Dyeing auxiliaries may be added as required for the standard dyeing process. After dyeing, the textile material is washed properly and soaping is carried out by 2 g/L industrial soap solution.

#### 2.6.2.3 Post-mordanting method

The dyeing process is carried out for bleached textiles in the absence of mordant at pre-determined dyeing condition and the dyed fabric is treated in a separate bath called saturator containing suitable mordanting solution. Treatment condition may vary depending on type of fibre, dye and mordant system. After dyeing, the textile material is washed properly and soaping is carried out by 2g/L industrial soap solution.(Prabhu & Bhute, 2012)

### 2.7 Harungana madagascariensis

A study was conducted to quantify some photochemicals present in hydroethanol (absolute ethanol: water 1:1 v/v) and methanol extracts of Harungana Madagascariensis stem bark traditionally used in the management of diabetes mellitus.(Iwalewa, Suleiman, Mdee, & Eloff, 2009)

Methodology; hydroethanol and methanol extracts of H.madagascariensis were separately prepared from the stem bark powder. The quantitative photochemical analysis of the hydroethanol and methanol crude extracts were carried out by employing standard conventional protocols for total phenols, tannin, saponin, alkaloids, and anthraquinone from plants.

Results; both samples showed the presence of all photochemicals investigated. The study revealed that hydroethanol extract of H. madagascariensis stem bark contained higher amounts of bioactive compounds in comparison with the methanol extract and this potential could be further exploited in drug development. (Sichilongo, 2015)

Results indicated that Harungana madagascariensis essential oils were highly terpenoidal, dominated by sesquiterpenes. They suggested the sesquiterpenes are taken as its taxonomic compounds. This study was the first of its kind which revealed important compounds in the leaf and stem essential oils of it, which have not been reported earlier in literature. The identified volatile metabolites may be contributing to the vast uses of Harungana madagascariensis in ethno-medicine. It is notable the distinct absence of fatty acids in this two oils. Other essential oil plant parts will be studied in the near future.(Abosede Wi & Jide Afola, 2017)

# CHAPTER THREE: METHODS AND MATERIALS

## 3.1 Materials and equipment

### Plant used

- Harungana madagascariensis for dye extraction.

### Materials used

- Alum mordant.
- Spectrophotometer: for color strength.
- Crockmeter: For rubbing fastness.
- Launder-o-meter: For washing fastness.
- Fadeometer: For light fastness.
- Water will be used for dye extractions.
- Gray scale for color fastness rating
- Weighing scales
- Measuring jugs
- Thermometer
- Mordanting and dyeing pans
- Stirring rods
- Storage containers
- Mortar and pestle

## 3.2 Collection of samples

Fresh plant materials (Harungana madagascariensis stems) were collected from Busitema forest reserve. The fresh harvested parts were dried under sunlight crushed using a mortar and a pestle and used for dye extraction.

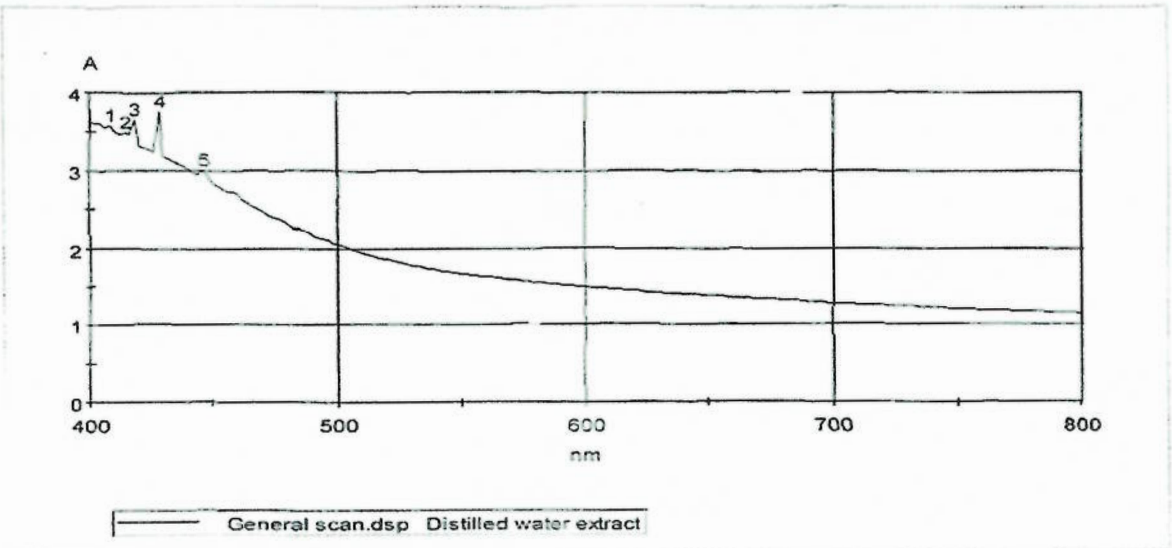
Degummed and bleached100% plain woven silk fabrics were purchased from the Uganda Industrial Research Institute (UIRI), Nakawa, Kampala district. Scoured and bleached 100% plain woven cotton fabric was also purchased from Southern Range Nyanza Limited in Njeru town.

### 3.3 Extraction of dye

The stem barks were pounded to powder using a pestle and mortar then 10g of powder weighed using a weighing scale and put in a beaker containing 100ml of distilled water, stirred, boiled and filtered.

**Working procedures.**

- The fabrics were dyed and allow it to dry in shade.
- After it was washed with soap, the dye extracted from the cotton cloth. Extract was with formic acid (5% by vol and methanol 95% by vol.)
- The extract was then run on a UV scan to get the wave length point at maximum absorbance.




General scan.dsp Distilled water extract

Maxima Threshold: 0.01 A

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 408 nm; | 3.571 A | 2 | 414 nm; | 3.495 A | 3 | 418 nm; | 3.646 A |
| 4 | 428 nm; | 3.765 A | 5 | 446 nm; | 3.003 A | | | |

Fig 3.0 showing a graph of the UV scan.

**For efficient extraction;** for 10g in 100ml. (5 solvent systems.)

- Distilled water.
- 5% methanol.
- 5% ethanol.
- 1% sodium bi carbonate(magadi)
- Acidic medium with acetic acid at pH. 3.5. all in water 500ml

**Getting the best solvent system for extraction.**

| 5 Solvent systems | | | | absorbance values (triplicate) | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | mean absorbance | standard deviation |
| Distilled water | 0.039 | 0.038 | 0.040 | 0.039 | 0.001 |
| Ethanol | 0.056 | 0.056 | 0.060 | 0.057 | 0.002 |
| Acetic acid | 0.023 | 0.026 | 0.023 | 0.024 | 0.002 |
| Methanol | 0.049 | 0.043 | 0.044 | 0.045 | 0.003 |
| Bicarbonate | 2.128 | 2.121 | 2.123 | 2.124 | 0.004 |
| | | λmax= 428nm | | | |

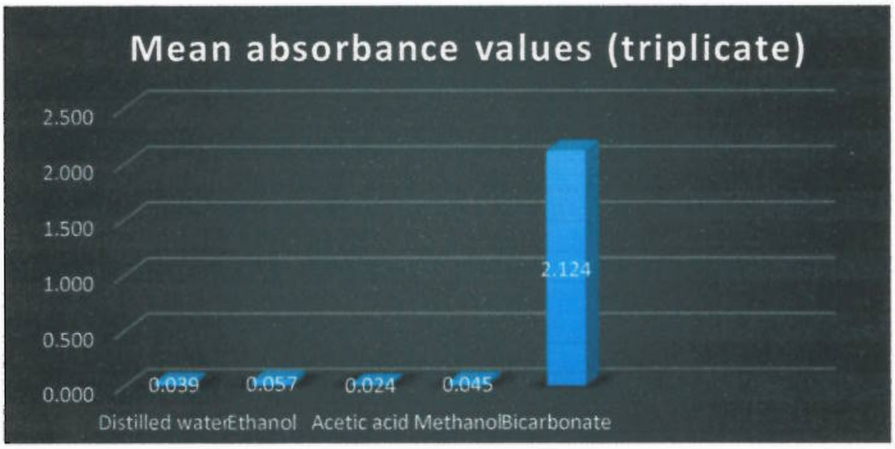



Fig 3.1 showing mean absorbance values for the solvent systems.

## CHECKING OUT FOR SIGNIFICANCE FROM THE DIFFERENT SOLVENT SYSTEMS

| Distilled wa | Ethanol | Acetic acid | Methanol | Bicarbonate |
|---|---|---|---|---|
| 0.039 | 0.056 | 0.023 | 0.049 | 2.128 |
| 0.038 | 0.056 | 0.026 | 0.043 | 2.121 |
| 0.040 | 0.060 | 0.023 | 0.044 | 2.123 |

Anova: Single Factor

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| Column 1 | 3 | 0.117 | 0.039 | 0.000001 |
| Column 2 | 3 | 0.172 | 0.057333 | 5.33E-06 |
| Column 3 | 3 | 0.072 | 0.024 | 0.000003 |
| Column 4 | 3 | 0.136 | 0.045333 | 1.03E-05 |
| Column 5 | 3 | 6.372 | 2.124 | 1.3E-05 |

ANOVA

| *Source of Variat* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Gr | 10.4109 | 4 | 2.602725 | 398376.3 | 5.84E-26 | 3.47805 |
| Within Grou | 6.53E-05 | 10 | 6.53E-06 | | | |
| | | | | | | |
| Total | 10.41097 | 14 | | | | |

Fig 3.2 showing the ANOVA values

From the graphs above, since my p-value is less than 0.05 then there is a significance in the values.

**Variation of bicarbonate concentrations.**

| Variation of Bicarbonate concentrations (absorbance values) | |
|---|---|
| Sample A (0.2%) | 3.652 |
| Sample B (0.4%) | 2.187 |
| Sample C (0.6%) | 3.761 |
| Sample D (0.8%) | 2.137 |
| Sample E (1%) | 3.745 |
| | |
| | |
| λmax= 428nm | |

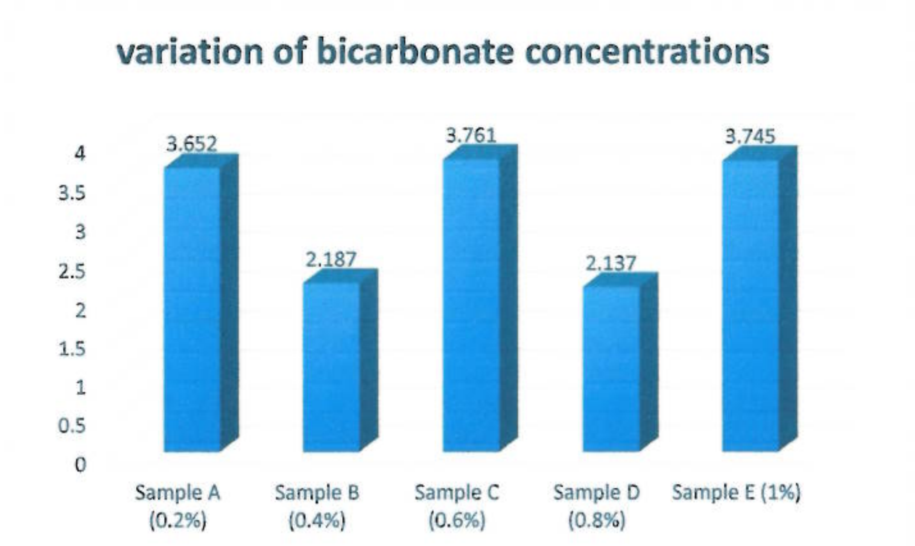



Fig 3.3 showing the variation of bi carbonate concentration

**Liquor ratio optimization.**

| Liquor ratio optimisation(absorbance values) | |
|---|---|
| Sample- 20ml | 4.989 |
| Sample- 25ml | 4.708 |
| Sample- 30ml | 4.725 |
| Sample- 35ml | 4.459 |
| Sample- 40ml | 4.266 |
| | |
| | |
| λmax= 428nm | |

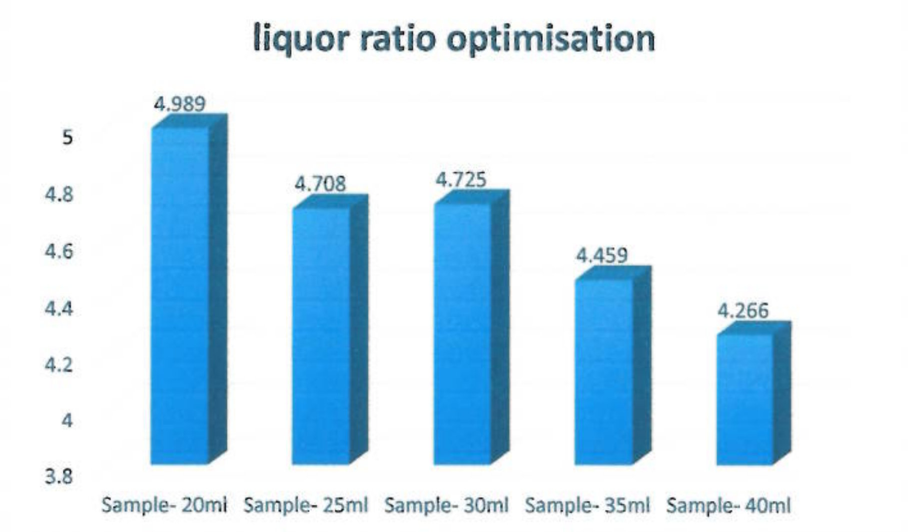



Fig 3.4 showing liquor ratio optimization for bi carbonate

**Time optimization.**

| Time optimization (absorbance values) | | | |
|---|---|---|---|
| Sample- 10 min | 4.046 | | |
| Sample- 20 min | 4.670 | | |
| Sample- 30 min | 4.709 | | |
| | | | |
| | | | |
| **λmax= 428nm** | | | |

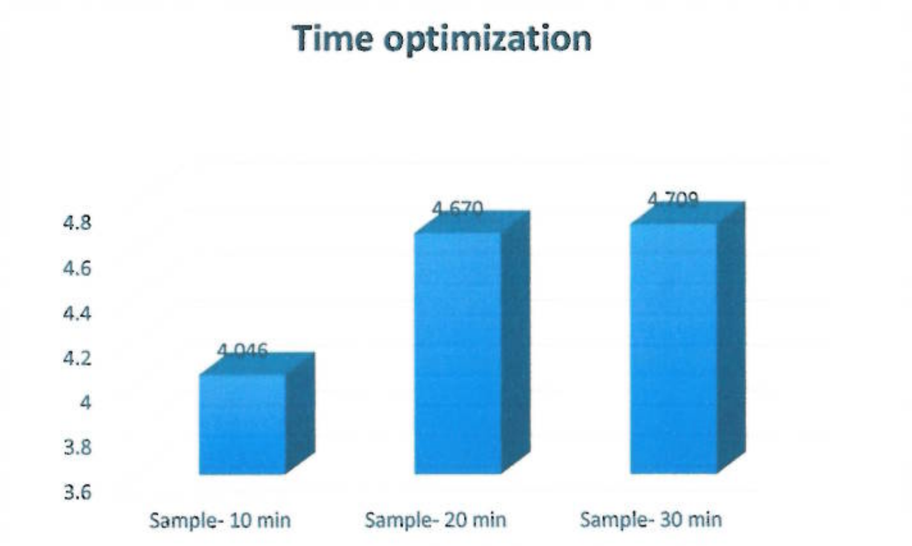



Fig 3.5 showing time optimization for bi carbonate

### 3.4 Dyeing and Mordanting

#### 3.4.1 Cotton fabrics

Cotton fabrics were dyed by post mordanting method.

A material to liquor ratio (LR) of 1:20 was used.

##### 3.4.1.1 Post mordanting

In post mordanting system of applying natural color on cotton fabrics, dyeing was done at optimum dyeing condition and the dyed samples were dipped into a mordant bath. Then followed by rinsing, soaping and thorough washing.

A control experiment was carried out. The cotton fabrics were directly dyed without applying any mordant.

#### 3.4.2 Dyeing of silk fabrics

##### 3.4.2.1 Post mordanting

In post mordanting system of applying natural color on silk fabrics, dyeing was done at optimum dyeing condition and the dyed samples were dipped into a mordant bath. Then followed by rinsing, soaping and thorough washing.

- Meta mordanting and pre mordanting methods were used in the assessment of color strength.
- Were in meta mordanting the fabrics were immersed in a dye bath solution containing both mordant and dye
- Pre mordanting the mordant was applied first on the fabric then followed by dyeing.

### 3.5 Assessment of the results

Colorfastness, the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials, or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage or use of the material.

### 3.5.1 Color fastness to light

Small samples of the fabric were cut and mounted on sample holders then exposed for 48 hours in the MBT light fastness tester. They were the removed and comparisons made on the part exposed to light and the unexposed part using a gray scale. Graded 1-8 where 1-4 shows poor fastness properties and 5-8 shows good fastness properties.

**Results**

| fabric | Gray scale reading | comment |
|---|---|---|
| **Cotton** | 2-3 | poor |
| **Silk** | 2-3 | poor |

Fig 3.6 showing light fastness assessment.

### 3.5.2 Color fastness to rubbing

Rubbing is the transfer of colorant from the surface of a colored yarn or fabric to another surface or to an adjacent area of the same fabric principally by rubbing. Dyed fabrics were tested for rubbing fastness according to the AATCC Test Method 8 standards. GC- 48 (cotton) was put on a Crockmeter then a wet and dry fabric was rubbed for 20times under controlled conditions and color transferred to the white test cloth was assessed by comparison with the gray scale and grade was assigned. In the dry-rubbing test, conditioning of the specimen for at least 4hours in a temperature of $21^0$C and relative humidity of 65. The specimen was placed flat on the Crockmeter base, the finger covered with the bleached fabric will be moved back and forth along a track of 50x130 mm on the dry fabric for 20 times making ten complete turns of the crank at the rate of about one turn per second. In the wet-rubbing test, the same procedure was used, with a fresh dry specimen and undyed cloth which had been wetted with distilled water and squeezed between two sheets of filter paper. Staining of white fabric by dyed fabrics was assessed with standard gray scale.

**Results**

| Fabric | Gray scale reading (crocked dry) | Crocked wet | Comment |
|---|---|---|---|
| **Cotton** | 3 | 3 | Good |
| **Silk** | 3-4 | 2-3 | Good |

Fig 3.7 showing rub fastness assessment.

### 3.5.3 Washing Fastness

Cut samples were weighed that's to say GC-48 (cotton) and the dyed fabric, placed in a beaker, 2g/l of penetrol was added. Then the machine was loaded for 30 minutes at a temperature of $60^0C$. After the samples were removed rinsed and dried at $60^0C$ in the oven. The stain on the GC-48 was compared with the gray scale marked from 1-5 where 5-good and 1- poor.

**Results**

| fabric | Gray scale reading | comment |
|---|---|---|
| **Cotton** | 3-4 | Good |
| **Silk** | 4 | Good |

Fig 3.8 showing wash fastness assessment

### 3.5.4 Color strength

Color strength of a pigments is defined as its ability to impart color to other materials. The lower the concentration of a colored pigment required to achieve a defined impression of color that is a given depth of a shade, the greater is color strength of colored pigments.

This was done using a spectrophotometer. The control experiment was first carried out then after getting the standard we mounted other fabrics to get the strength in relation with the standard the comparison was made between the different mordanting methods. That's to say pre-mordanting, meta-mordanting and post mordanting methods for both cotton and the silk. Then readings from the machine were printed out showing the color strength.

**Results**

| Fabric | Pre-mordanting strength | Meta-mordanting strength | Post-mordanting strength |
|---|---|---|---|
| **Cotton** | 123.36 | 155.18 | 249.90 |
| **Silk** | 152.57 | 203.29 | 140.75 |

Fig 3.8 showing color strength assessment.

## CONCLUSION

The dye potential of Harungana madagascariensis stem barks was evaluated with the dye efficiently extracted using sodium bi carbonate as the best solvent medium with the highest absorbance. However, the fabrics showed good color fastness to washing and rubbing but poor light fastness.

For color strength, cotton showed the highest value with post mordanting method and silk had the highest value with Meta mordanting method.

### RECOMMENDATION

I would recommend more research to be carried out on natural dyes which are eco-friendly and should work as an alternative for the synthetic dyes. Then light fastness properties should be worked on with more research so as to improve the properties.

Textile laboratories should be well equipped with necessary chemicals to reduce the cost of moving to other universities for their laboratory services.

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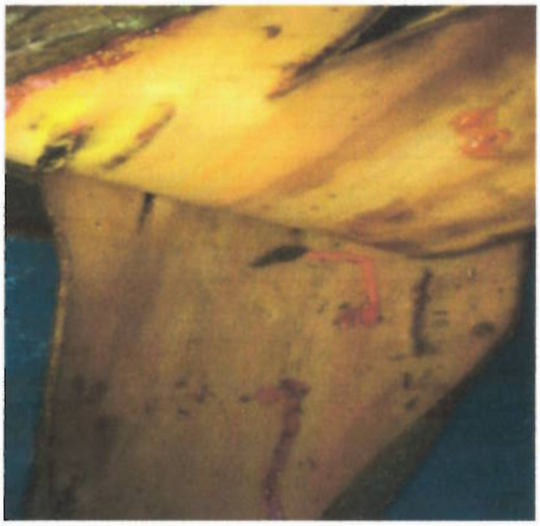
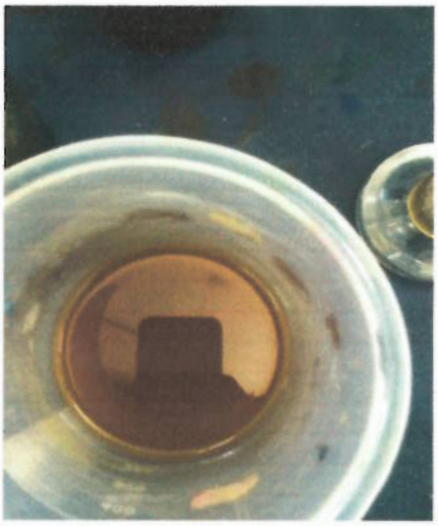
## APPENDIX

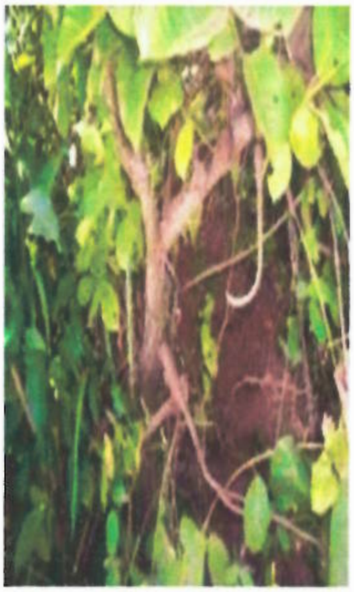


The stem bark of Harungana.

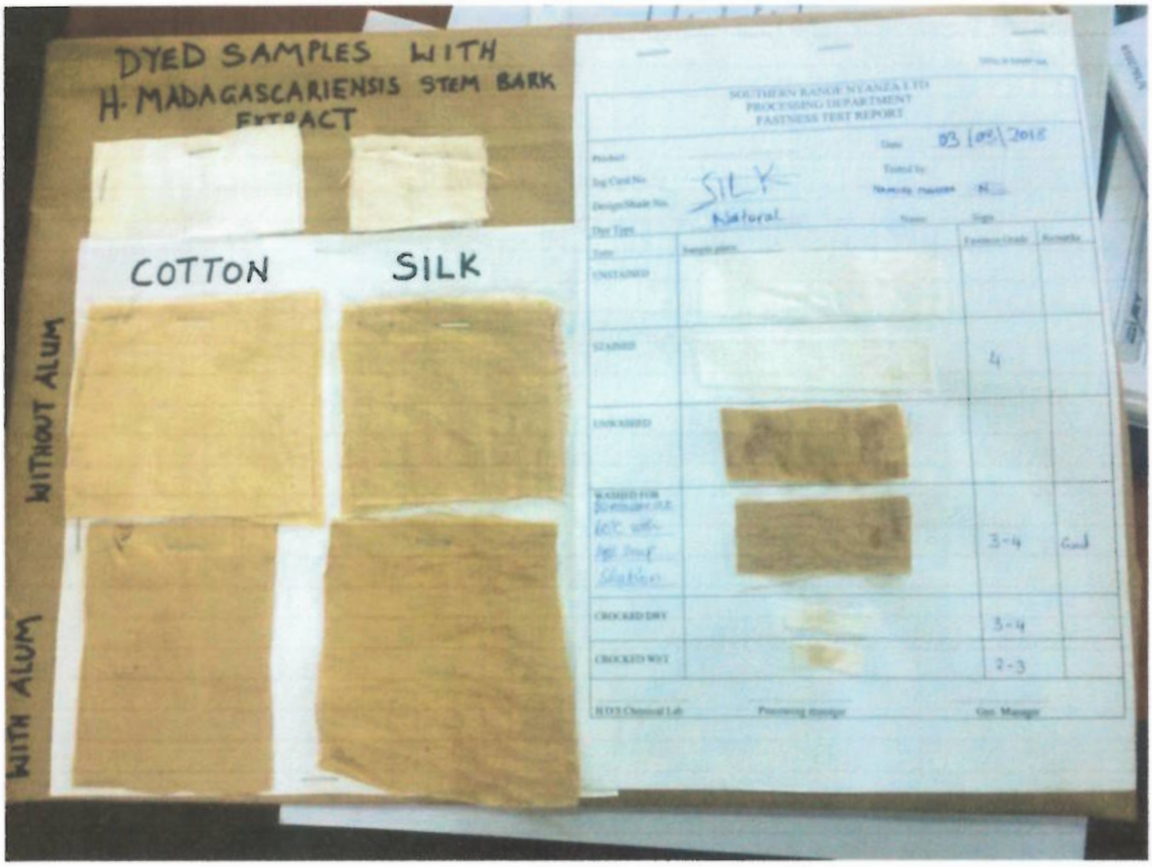


The dye extract after filtration.

Powder of the stem bark.



Shrub of H. Madagascariensis.




**Board showing color fastness assessment.**