COLOR SHADES FROM *VITELLARIA PARADOXA* DYE ON COTTON FABRIC

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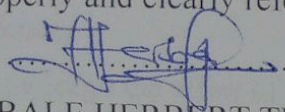
DECLARATION

I declare that the work contained in this dissertation is original, having been done by myself under the guidance of both my supervisors and that whichever external material used has been properly and clearly referenced.

Signed..  .....

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Finally, I thank the management of Southern Range Nyanza Textiles (NYTIL)-Jinja for allowing me to use their laboratory facilities for testing my samples, most notably Mr Ebaju, who personally directed me on how the tests are done.

DEDICATION

I dedicate this work to all the underprivileged, who, amid enormous hardship, labour through this, so often non equitably recompensing education system and pray that life in one way or the other gives a fair verdict to their endeavours.

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LIST OF ACRONYMS

AATCC	Association of American Textile Colourists and Chemists
CC	Colour change
CS	Colour stain
ISO	International organisation of standardisation
NYTIL	Nyanza Textile Industries Limited

ABSTRACT

This dissertation reports a project aimed at extracting a natural dye from *vitellaria paradoxa* and production of different shades on cotton fabric using single and combination Mordants where two mordants are combined in quartile proportions. Aqueous extraction was used to obtain a crude dye solution from fresh, dried and pulverized stem bark which was immediately used for dyeing using the simultaneous mordanting technique. Mordants used in this study included ferrous sulphate, alum and potassium dichromate. The shades developed were then assessed for color fastness to determine their usability.

The results revealed that the natural dye from *vitellaria paradoxa* is a monogenetic dye giving a variety of soft, dark and light shades of pink and warm grey with alum, ferrous sulphate, potassium dichromate and their combinations.

Fastness grades for single mordants were found to be good to excellent with the exception of those mordanted with ferrous sulphate that tended to score a little lowly. Combining Alum and ferrous sulphate generally improved the fastness rating of the samples except for two samples i.e. 1:3 in light fastness and 3:1 in wet rub fastness. Combination of Alum and Dichromate produced grades that were good to very good except for 1:1 and 3:1 in wet rub fastness. Combining Ferrous sulphate and Dichromate also rated good to very good, however, the impact of ferrous sulphate is clearly seen as the results tend to deteriorate as the proportion of ferrous sulphate increases in the bath.

The shades developed therefore were conclusively useable though efforts should be made towards standardization of all dyeing and extracting parameters for *vitellaria paradoxa* and isolation and purification of the active coloring component in *vitellaria paradoxa* which I believe would be a further advancement towards the commercialization of the natural dye and indeed natural dyeing in Uganda's textile industry.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Natural dyes cover all the dyes derived from the natural sources like plants, animal and minerals. Natural dyes are mostly non-substantive and must be applied on textiles by the help of mordants. Mordants are usually metallic salts, having an affinity for both the coloring matter and the fiber. When a textile material has been mordanted and is subjected to dyeing with different natural dyes (usually having mordantable groups facilitating fixation of such dye), these mordants, form an insoluble precipitate enabling both the dye and mordant to get fixed into the fabric(ashis and Adwaita, 2009).

The use of mordants was sparked off by the poor fastness properties of natural dyes and their limited color yield. Different mordants or their combination can be applied on the textile fabrics to obtain varying color or shade, to increase the dye uptake and improve the color fastness behavior of any natural dye even for the same natural dye.

Ashis and Adwaita, 2009 assert that a mordant is more important than the natural dye itself simply because the final color produced by the natural dye, the color brilliance and color fastness properties are not only dependent on the dye but also on varying concentration and skillful manipulation of the mordants.

This is the basis of this project, to be able to produce beautiful color fast shades from the use of whole and a combination of mordants on cotton fabric targeting mostly the highly enterprising artisanal sector, a priority sector in light of Uganda's vision 2040.

Various studies have been carried out by different scientists on the effect of mordants and Mordanting techniques but little work has been done on mordant combinations. It is reported that color depth varies from mordant to mordant and mordanting technique to technique. It is also reported that a wide range of tints and shades can be developed using combination of mordants with apricot leaf dye and use of various mordants in printing with marigold flower dye (Neelam pruthi, 2006).

1.1.1 The *vitellaria paradoxa* tree

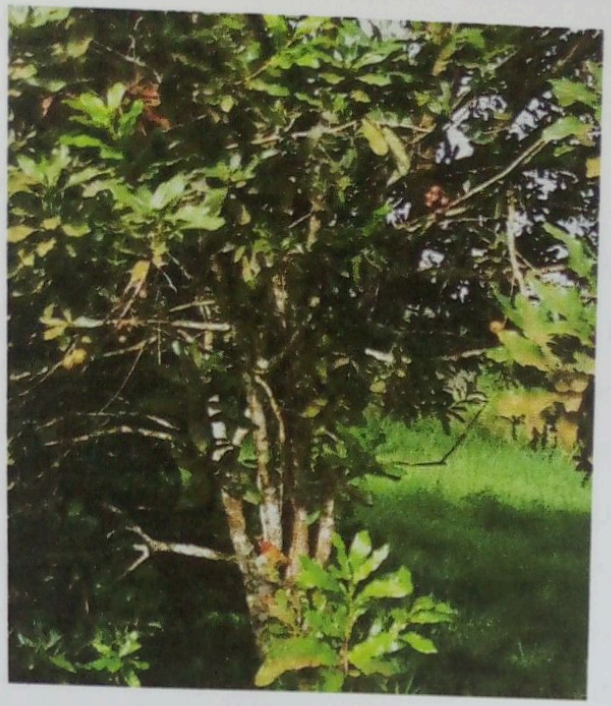

Figure 1*vitellaria paradoxa tree*

Figure 2 ***vitellaria paradoxa*** **tree trunk**

Vitellaria paradoxa is a member of the Sapotaceae family, and is divided into two sub species: nilotica and paradoxa. The ranges of the two are mutually exclusive, although they have been found within 175 km of one another (Hall et al.1996). The *Vitellaria paradoxa* subsp. nilotica is located primarily in Uganda and Sudan, with some occurrence in Ethiopia

and Zaire, while the *Vitellaria paradoxa* subsp. paradoxa is found in areas from the Central African Republic to Senegal (Hall et al. 1996). The difference between the two subspecies occurs primarily in the consistency of the fat content found within its nut (Boffa 1999).

Growth of the tree

It usually grows to an average height of about 15m with profuse branches and a thick waxy and deeply fissured bark that makes it fire resistant. It's a deciduous tree with a spherical crown. The Shea tree grows naturally in the wild in the dry Savannah belt of West Africa from Senegal in the west to Sudan in the east, down to Uganda and onto the foothills of the Ethiopian highlands (University of Ghana, Research and development of the Shea tree and its products, 2002). The flowers, which appear from December to March, are greenish yellow and occur in terminal groups of approximately 30 to 40. *Vitellaria paradoxa* is insect pollinated, and as such is often associated with bees (Maydell 1990).

For many years, people have selected which trees to include in their fields, a process that has left *Vitellaria paradoxa* as the dominant tree in most parkland systems in the West African Sudano-Sahelian landscape (Hall et al. 1996).

Vitellaria paradoxa thrives on dry sandy clay soils that have a good humus cover, but occurs on a variety of soil types (Hall et al. 1996). It has an extensive root system, which helps it to tolerate the extended dry season (up to eight months) and occasional droughts of the savanna. The annual rainfall in *Vitellaria paradoxa* range averages from 600-1,500 millimeters (Maydell 1990).

Vitellaria paradoxa subsp. *paradoxa* occurs mainly between elevations of 100- 600 meters. The *Vitellaria paradoxa* subsp. *nilotica* occurs at elevations of about 1200-1600 meters, but there exist a few populations in Sudan at 500 meters (Hall *et al* 1996).

Consequently the subspecies *nilotica* occurs, on average, at higher elevations than the subspecies *paradoxa*.

Generally, *Vitellaria paradoxa* reproduces naturally and, although it may be aided in its reproduction by being protected from fire or grazing livestock by including it in farm lands, it is not traditionally planted (Hall et al. 1996).

Local uses of the tree

There are many reported uses of *Vitellaria paradoxa* in its range. Oil from the kernel of the Shea seed is the principal source of fat in many local diets (Saul et al. 2003). The wood from *Vitellaria* can be used as a high quality fuel wood and to make sturdy tools (Boffa et al. 2000). The oil and butter are used as a lotion for the skin and hair, although in many areas

these traditional products are being replaced by commercially produced lotions. *Vitellaria paradoxa* is also valued medicinally for soothing arthritic pains, reducing swelling, treating skin problems, and as an antiseptic for the treatment of wounds (Boffa 1999). The butter can also be used as a waterproofing material for huts and walls.

International uses of the tree

Vitellaria paradoxa has become an important non-timber forest product on the international market. The products are exported in one of two ways;

Either the nuts themselves, after being roasted, are exported in bulk, or the nuts are processed into Shea butter within the country of origin, and then exported (Boffa 2000)

Notable among the non-butter products of *vitellaria paradoxa*; Infusions of the bark have shown to have selective anti-microbial properties, as being effective against Sarcina lutha and Staphylococcus mureas but not mycobacterium phlei (Malcolm & Sofowora, 1969). Macerated with the bark of Ceiba pentandra, and salt, bark infusions have been used to treat cattle with worms in the Tenda region of Senegal and Guinea (Ferry et al., 1974). The infusions have been used to treat leprosy in Guinea Bissau (Dalziel, 1937) and for gastric problems (Booth and Wickens, 1988) as well as for diarrhea or dysentery (Soladoye et al., 1989). A bark decoction is used in the Cote d'Ivoire in baths and therapeutic sitz-baths to facilitate delivery of women in labour, and is drunk to encourage lactation after delivery (Abbiw, 1990; Soladoye et al., 1989; Louppe, 1994). A bark infusion is used as an eyewash to neutralize the venom of the spitting cobra (Soladoye et al 1989) and also, in Ghana, as a footbath to help extract jiggers.

Prospective uses of the tree

The Shea tree also has a great, untapped capacity for producing great amounts of sap that can be an important source of raw material for the gum and rubber industry.

The International Agroforestry Centre ranked *vitellaria paradoxa* among the top priority plants for domestication in the Sahel region (Leakey 1999).

1.1.2 Importance of shade development

Since time immemorial, humans use and enjoy color. Just look at the colorful products and art that our ancestors produced, such as artifacts and fabric from the early Egyptian civilizations, to realize the importance of color to humans.

Natural dyes are known to produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are readily available at an economical price

and produce a wide variety of colors; these dyes however produce skin allergy, toxic wastes and other harmfulness to human health (ashis and agwaral, 2006).

The textile and retail businesses worldwide use color to segregate and market materials, products, and product lines.

Color variety and new color or shade development are major driving forces in the production and marketing of textiles as well as numerous other products (Basics of color for cotton textile products, *technical bulletin*).

However, for such an important aspect of industry, commerce, and everyday life, the concept of color, the production of color, and the control of color, especially on textile products, are poorly understood by textile producers, merchants, and consumers (Basics of color for cotton textile products, *technical bulletin*).

For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without adversely affecting quality of dyed textile materials. Therefore, to obtain newer shades with acceptable color fastness and reproducible color yield, appropriate scientific techniques or procedures need to be derived from scientific studies on dyeing methods, dyeing process variables, dyeing kinetics and compatibility of selective natural dyes. A need has been felt to reinvestigate and rebuild the traditional process of natural dyeing (preparation and Mordanting) and dyeing process variables for producing uncommon shades with balanced fastness and eco-performing textiles (Samanta and agarwal,2009)

This project is intended to add to the pivotal topic of shades and shade development that can be developed on cotton fabric with a natural dye from *vitellaria paradoxa* using whole and a combination of mordants and to evaluate the resultant color fastness of the dyed samples to washing, rubbing and light.

1.2 Problem statement

It's quite obvious that the use of synthetic dyes presents several setbacks ranging from skin allergy and other harmfulness to the human body to large amounts of toxic effluents. The global consumption of textiles is estimated at around 30 million tons, which is expected to grow at the rate of 3% per annum. The coloration of this huge quantity of textiles needs around 700,000 tons of dyes which causes release of a vast amount of unused and unfixed synthetic colorants into the environment (Nattadon and Rattanaphol, 2012), let alone the fact that synthetic dyes are petroleum based and therefore nonrenewable. In this case natural dyeing is considered a matter of insight

On the other hand however, even though natural dyes have been advocated for as substitutes to synthetic dyes because of increased environmental awareness due to their non-toxicity and eco friendliness, their viability for extended usage necessitates scientific studies on dyeing methods, dyeing process variables, dyeing kinetics and compatibility of selective natural dyes, generally speaking, the 'natural dyeing chemistry', to obtain newer shades with acceptable color fastness behavior and reproducible color yield. This information is specific for a given dye-fiber system and in this case insufficient for the natural dye from *vitellaria paradoxa*.

1.3 Objectives

1.3.1 *General objective*

Development of color shades from *vitellaria paradoxa* dye on cotton fabric with the use of single and a combination of mordants

1.3.2 Specific objectives

i. Extraction of the dye from the plant stem bark

ii. Dyeing of cotton fabric with the extract using different mordants

iii. Identifying the color shades formed on the cotton fabric

iv. Determining color fastness to washing, rubbing and light

1.4 Justification of the project

Revitalization of natural dyeing comes with a number of positive impacts;

First and foremost, natural dyeing is a cultural sentiment, by returning to dyestuffs associated with specific cultures, which knowledge is in danger of extinction. Furthermore, economic and human development aspects come into play in terms of incomes to craftsmen, artisans and producers involved in the sector (Anna Roquero, a return to natural dyes). Sustainability is another important factor especially when eventually the fossil resources are depleted therefore natural dyeing is a matter of insight. Finally, the special aesthetic qualities coupled with the "green label" significantly add value to the products both as crafts work and as an industry.

On the other hand, finding a lasting solution to the problem of synthetic dyes requires that the alternative put forward is a perfect substitute thus the need for studies into sources of newer beautiful shades with acceptable color fastness behavior and reproducible color yield. Neelam Pruthi et.al,2006 reports a slight improvement in fastness properties with brighter and deeper shade ranges when combination of mordants were used as compared to a single mordant during the dyeing of silk with barberry bark dye. This information on other natural dye-fiber systems however is insufficient. That is why this project is very much relevant to the current need of the textile dyers and the textile industry as a whole in relation to *vitellaria paradoxa*, a source, already popular for multifunctional application hereunder; edible fruits, vegetable sauce, construction, firewood, medicine, commerce and field trees, adding to its functionality and consequently its conservation priority.

1.5 scope of the project

This project will cover aqueous dye extraction technique, single and combination mordants in simultaneous Mordanting method, color shade description and color fastness determination to washing, light and rubbing using a natural dye from *Vitellaria paradoxa.*

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