DETERMINATION OF THE AMOUNT OF DYE EXTRACTED FROM PLANTS AND EXAMINATION OF THEIR FASTNESS PROPERTIES TO COTTON FABRICS

BY

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A thesis submitted to the Postgraduate School, Ahmadu Bello University, Zaria, Nigeria in partial fulfillment of the requirements for the degree of Master of Arts in Industrial Design

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This thesis entitled "Determination of the Amount of Dye Extracted from Plants and Examination of their Fastness Properties on Cotton Fabrics" by Nyam Bitrus Bin meets the regulations governing the award of the degree of Master of Arts (Industrial Design) of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

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The problem of this study is to investigate the extent to which dyes can be extracted from plants as well, as examining their fastness properties to cotton fabrics. The purposes of the study are to determine ways and the amount of dyes that can be extracted from plants, the effects of geographical environment, mordants and water on plant dye.

Throe dye plants, bixa, turmeric (gangamau, magina) and onion skins (albasa) were selected. Also selected were tap and well water and six types of mordants, wood ash, copper, chrome, iron, tin and alum.

The data for this study were obtained by raising the temperature of the dyebath and mordant bath to boiling point and room temperatures for 5 to 120 minutes.

From the analysis of data, it is conclusive that:

1. Extraction of dye is made by boiling the dye material for 30 minutes.

2. 20 grams of bixa and turmeric are each capable of producing 1.5 grams and 2.7 grams respectively, while 20 grams of onion skins produce 150ml. of dye solution.

3. Geographical environment of plant dye is only significant as a result of mordant.

. Effect of water on plant dye depends on the plant and mordant used.

5. No significance difference is observed in colour between room and boiling point temperature mordanting.

6, Mordants help in varying the colour of the same dye plant as well as making the colour fast.

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D E D I C A T I O N

To GIMBIYA my beloved wife, YODEH and GBERE
my beloved daughters for their LOVE.

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CHAPTER - I

1.1 Introduction
1.2 Historical Background
1.3 Statement of the Problem
1.4 Purposes of the Study
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1.1 INTRODUCTION

The present generation is very sensitive to colour and perhaps this is the main reason in the increase demand of sophisticated textile goods by consumers. The traditional indigo dyers only produce shades of blue which does not seem to meet this increase demand by consumers.

Those who take dyeing as a trade cannot continue at present this is because the imported synthetic dyestuffs they depend upon are hard to come by. This inadequate supply of textile dyes is also applicable to nearly every textile decorator in this country.

Most textile companies today operate at a fifty percent production capacity, while others operate only marginally. This sudden drop in production capacity, according to Mohammed, (1984) was mostly attributed to lack of raw materials, dyestuffs being an essential part.

Nigeria has a wide variety of domestic sources of dye as discovered by Eicher, (1976). The degree of foreign importation can therefore, be reduced if our local sources or materials are investigated and refined. These local materials for dyes may be discovered to be a good substitute for the imported synthetic dyestuffs if not better. It is then, our dependence on the synthetic dyestuffs with

its consequent drain on foreign exchange reserves could be brought to an end within a relatively short period of time.

Rice,(1963) once described dye as colour-forming substance intentionally applied to the fabric or fibre by special treatments to produce a possible permanent concentrated colour. He went on to say that the coloured chemicals, whether natural or synthetic, are often called "dyestuffs".

When the word "dye" is mentioned, one should not only think of the cloth alone because dyes could also be used to colour other things such as leather, paper, food, cosmetic, human hair and animal furs. However, this study will only be confined to those dyes that colour textile fabrics.

1.2 HISTORICAL BACKGROUND

According to Giles,(1974) until the middle of the last century, all dyes were said to be natural products extracted, in most cases from a variety of plants, but also from animals sources. Lyttle,(1974)

also reports that farmers harvested leaves, flowers, roots or bark from various plants that they (farmers) cultivated just to get dyes. In some regions, he went on, insects were patiently collected for dyes. Storey, (1978) reports that natural dyes with very few exceptions have little or no colouring power themselves but must be used in conjuction with mordants (metallic salts such as alum).

Storey,(1978) is of the opinion that the craft of dyeing was understood in Europe in Pre-Roman times and afterwards, but was lost during the years following the break-up of the Roman Empire. In the middle East and the Orient, she continued, the knowledge of dyeing was preserved and was gradually brought back into southern Europe and Spain by the Arabs during the early eighth century A.D. According to Lyttle,(1974) the Chinese began the use of natural dyes about 300 B.C. In Europe, he continued, dyeing practice started as early as 200 B.C. by the Swiss Lake Dwellers. He further stated that fabrics found in the tombs

of ancient Egypt revealed that the craft of dyeing was known at least as early as 2500 B.C. Giles in Macropaedia,(1973 - 1974) revealed that 'Saflower' an old world herb (also called dyers' thirsitle) was said to be used by the Egyptians around 200 B.C. to obtain yellow and red shades. This source further stated that by 1450 B.C. ways of dyeing fine fabrics principally linen, in full range of hues had been gradually envolved.

In 1886, Lyttle,(1974) reports that an 18 year Chemistry Student in the name of William Henry Perkin who was working in his home laboratory near London, England, accidentally made a violet dye from an extracted coal tar. That was the first synthetic dye. Giles,(1974) believes that the colour of the dye discovered by Perkin was purplish and he, Perkin, called it "Mauve". This colouring matter, Giles continued, dyed silk directly. Three years later, he further stated, other chemists also discovered some other colours which were all synthesized from aniline which was derived from coal tar. Thus, England

claims to be the discoverers of aniline dyes. Welford,(1950) affirms that aniline in its original state is not in a soluble form for the extraction of dyes. It has to be, he continued, oxidized with strong oxidizing agent such as potassium bichromate. This, he said, converts it into dark coloured solid from which dyes are extracted by means of solvent (e.g. methylated spirit). Welford also reports that by a process known as "diazatization", aniline can be changed into a compound which is the source of a large range of dyes known as "Azo" dyestuffs. Welford also reports that in 1869, another dye called 'alizarin' which is said to be identical in its composition with madder (a natural dye produce from the root of a plant). Other discoveries in history include:

(a) Basic Dyes

Giles,(1974) believes that these dyes were discovered in 1859. According to Storey,(1974) these dyestuffs were the first coal-tar colours developed by Perkin and Hofmann.

(b) Vat Dyes

Giles in Macropaedia,(1973 - 1974) believes that indigo, a time was the sole example of a "Vat" dyestuff, that is, one applied from a "Vat" containing alkali (sodium hydroxide) and a reducing agent (hydrosulphite) in which the insoluble dyestuff was temporarily solubilized during dyeing. This, the source further stated, the "Indanthrene blue", (1901) the first of the modern type of vat dyestuff, based on anthraquinone, was introduced. Giles, (1974) confirms that vat dyes were discovered in 1901 and 1906.

(c) Disperse Dyes

Discovered in 1923, Giles,(1974). According to Potter and Carbman,(1967) these dyes were developed originally for dyeing acetate fibres and have since found wide use in dyeing triacetate, nylon and polyester.

(d) Reactive Dyes

Reactive dyes were believed to be discovered in 1956, Giles,(1974) by I.C.I. of England. According to Potter and Carbman,(1967) reactive dyes were first developed for cellulosic fibres but can now be applied to wool, silk, nylon, acrylics and blends of these fibres. Thomson,(1981) is of the view that these dyes give colours that are very fast to washing and to light. Seagroatt,(1975) reports that there are two types of reactive dyes which are readily available, Dylon (cold water dye) and Dylon Multi-purpose dye.

(e) Pigments

According to Storey,(1974) the most important textile pigments in the nine-teenth century include chrome yellow and orange, Guigent's green, ultramarine blue, vermillion, sienna, umber and ochre. She further argued that formerly, pigments were steamed for about an hour. In 1927, according to her, Henride Diesbach, a

Professor at Friburg, prepared an organic compound containing copper and produced an intense blue colour which was highly resistent to chemical reagents. Six years later, Storey continued, further research was carried out at Imperial College, London, and in 1934 I.C.I. brought out 'Monsstral Blue' and I.G.F. Ferber' Hebogen Blue B'. She further stated that this colour was applied either to man-made fibres by addition to the spinning solution in finely dispersed form or to any textile material with thermosetting resins or binders and it is fast to washing. Potter and Carbman,(1967) are of the opinion that pigments are not true dyes because they have no affinity for the fibre and are applied and held to the fabric with resins, which are then cured at high temperatures.

With the discovery of the synthetic dyes about the middle of the nineteenth century, according to Lyttle,(1974) the natural dyes were largely replaced by the synthetic dyes. As a result, he said, the natural dyes lost

their commercial value though they are still remain of high interest to historians. Craftsmen and women are still today using these dyes because as Thurstan,(1949) rightly reports "These colours are alive as all beauty is alive and that is why we would like every craft worker to learn something of vegetable dyeing". But how and when did the art of applying colour to textile fabrics start? This art, the source of which is difficult to pin-point could however, be classified as one of the ancient crafts. As earlier discussed, the history of dyeing can be traced back to at least four thousand years. Noah,(1984) believes that the art of applying colour to textile fabric went far back into antiquity. The unearthing, he continued, of coloured fabrics in the excavations in Egypt and Asia had proved beyond question that textile colouring was developed independently and practised by almost all primitive peoples. This art of applying colour to textile fabrics probably happened after the early man had left the cave and

was looking for protection for himself and that of his family. At first he probably protected himself and that of his family against the bitter cold with animal skins which became comfortable anly after a long usage.

Adetoro,(1979) reports that later, man was able to extract cotton and wool threads to weave cloth. But man, he continued, again discovered that this white cloth went dirty just after a short usage. So the earlier colour application to textile fabrics probably was made by man who observed the stains left by various parts of plants. With this discovery, Adetoro further stated, some colour ingredients extracted from the sap of plants were used to colour the cloth. The colour allowed usage of the fabrics for a longer time before being washed and allowed the cloth to be durable. A few other reasons for the colour application to the fabric, Adetoro concluded, could be aesthetism and prestige. Among the earliest and

most popular sources of natural dyes known to man include Indigo, Woad, Logwood, Madder, Tyrian purple, Kermes and Cochinedl.

1.3 STATEMENT OF THE PROBLEM

The problem of this study is the extent to which dyes can be extracted from plants as well as examining the fastness properties of such dyes on cotton fabrics.

1.4 PURPOSES OF THE STUDY

The purposes of this study are as follows:

1. To determine ways by which dyes can be extracted from selected dye plants.
2. To determine the amount of dyes that can be extracted from any quantity of certain species of plants.
3. To determine the degree of fastness these dyes are to cotton fabrics.
4. To determine the type and amount of colour a plant can yield in certain geographical environment concerned with in this study.

5. To determine the contribution of mordant to the types and quality of dye produced.

6. To determine the effect of the type of water used in carrying out vegetable dyeing.

1.5 RESEARCH QUESTIONS

The research questions are as follows:

1. What ways will be appropriate for extracting dyes from plants?

2. What amount of dyes can be extracted from a determined quantity of certain species of plants?

3. To what degree will some dyes be fast on cotton fabrics?

4. What type and amount of colour could a dye plant yield in a certain geographical environment?

5. What contributions will certain mordants make to the extraction of some dyes from plants?

6. Will the type of water used in carrying out vegetable dyeing have any effect on the shade of such colour?

1.6 BACKGROUND AND SIGNIFICANCE OF THE STUDY

The deplorable and disturbing situation facing the Nigerian textile industries, the "buy-made-in-Nigeria goods" slogan and the increasing demand of sophisticated textile goods by consumers are some of the crucial issues to this study.

Scanty literatures seem to have been written on vegetable dyes, especially in Nigeria. Most research works on these dyes are conducted either in Britain or United States of America. The applicability of such findings to the local situation like Nigeria is therefore, questionable. Thursan,(1949) records that in Britain, for example, a shrub known as black berry yielded a brownish grey colour for alum mordanted wool. Also according to Mustard,(1977) in United States of America, black berry yielded just grey for also alum mordanted wool. One sees here that this shrub varies its colour from one geographical

environment to another. In the Nigerian environment one may likely ask about what a black berry is, or is this shrub also grown here in Nigeria? Again one may ask, knowing fully well that wool is hard to come by, if the above experiments done by Thurstan and Mustard were done on cotton fabric which is easily available, what could have been the result? In Nigeria, there seems to be no research uptill now to determine or to answer some of the above and other questions to be followed. These were what the study attempted to answer.

Some earlier study have shown that plants grown in different geographical areas which have their particular seasonal and climatic conditions may produce different shades of colour. The available literature on the study also showed that the type of water used in dyeing fabrics may slightly produce different colours when used for the same dye plant.

Bliss,(1980) is also of the view that the chemical make up of the soil in which the dye plant is gathered will affect the colour of the

dye. She went on to say that some dyers used only rain water or melted snow to avoid the minerals contained in the water. Seasons in Nigeria are quite different from those of the other dyers she talked about. If one should therefore, use only rain water for vegetable dyeing, the process will only be possible as from April to November and in some parts of Nigeria this can only be possible from July to September. There is no season of the year in Nigeria which is so cold to cause snow fall.

Castino,(1975) declares that it is also the plant-mordant combination that determines the final colour of a dye. Bliss,(1980) also believes that various mordants produce different final results from the same bath because of their ability to alter the dye colour. Brown, (1978) confirms that a plant known as fustic for instance, yielded gold colour for wool mordanted with chrome and yielded yellow tan for wool with alum mordant. In a nut shell, all that has been said so far are the likely factors that will influence vegetable dyeing.

The researcher's experience during and after his national service year on inadequate supply of textile dyes is an area of concern. The researcher also believed that this problem was applicable to nearly every textile decorator in this country. For example, some of the home dyers who take dyeing as a trade, cannot continue now. This is because the synthetic dyes they depend upon are hard to come by. Even if these dyes are found in the market, they are sold at an exorbitant price. For example, the Adejumo Farm in Kaduna (a well known shop where commercial dyestuffs are sold) only at present sells yellow colour, other colours are not in the market. With time, there is the probability that there will be no more dyestuffs in that shop and when this happens, the textile decorators in and around Kaduna will run into trouble of not getting dyestuffs. This problem of inadequate availability of textile dyes can be reduced when one turns attention to dyes that can be extracted from the plants.

Most textile companies today operate at a fifty percent production capacity, while others

operate only marginally. This sudden drop in production capacity, according to Mohammed, (1984) was mostly attributed to lack of raw materials. The National Union of Textile Garment and Tailoring Workers of Nigeria recorded in the National Concord Newspapers, (1984) that in various Nigerian Textile Industries, at the close of 1970s, the total number of workers employed was estimated at 2,000,000 but as at December, 1983, this figure dropped to about 80,000, this was a loss of 120,000 in the last five years. As at now, this source continued, about one-third of the textile mills have temporarily closed down while the remaining two-thirds are operating at between thirty percent and forty percent capacity. Some, the Union further stated, are operating on 3-day a week basis. This situation has led to redundancy of another 8,000 workers between January and now, the Union continued. The Union is of the opinion that in addition, about 10,000 workers had been forced on compulsory leave ranging from six weeks to three months and some on half salary or no salary at all. The main reason has been

attributed to lack of raw materials, dyestuffs being an essential part. One should then wonder why attention should not be given to those dyes that can be extracted from plants to alleviate the problem.

Mohammed,(1984) recommends that the Federal Military Government should establish a Commission which will look into the problem of shortage of raw materials. He further suggested that the Commission should comprised of eminent scholars and proven professionals which includes the textile artists. One would agree with Mohammed here that when such a meagure is taken, the problem of raw materials will almost be over. To further support this arguement, the Commission's recommendations should not just end as mere report largely unread but made into practical use.

In an attempt to boost local raw material, Asuelimen,(1984) is of the view that Nigerian Industries (including the textile industries) should produce or grow their major raw materials. In the case of the Nigerian Textile Industries, why can't they and the government encourage the

growth of dye producing plant like indigo or onions that can not only be used as textile dye, but for consumption? Onwumere,(1984) also points out that "... by cherishing and purchasing goods produced domestically, our economy will get a boost". That is to say, our local industries will strongly tend to be in full operation and this will result in people retaining their jobs. He further argued that workers and firms would also pay taxes which would be used to provide services for the development of the society. By cherishing and purchasing "made-in-Nigeria goods", skill would be acquired by some Nigerians and above all, he concluded, our cultural and National identity would both be promoted and protected.

The recent call by the National Union of Textile Garment and Tailoring Workers of Nigeria to the Federal Military Government as contained in the National Concord Newspapers, (1984) would probably be regarded as a wrong statement by Textile Scientists and Artists. The Union believed that the Federal Military Government should increase the issuance of

Import Licences to the textile sector since it is the largest employer of labour in the private sector of the economy. One may ask, will the increase of import licences bring a lasting solution to the problems facing the Nigerian Textile Industries? For a lasting solution, one would have thought that the Union would have advised the Federal Military Government to encourage the textile artists and scientists to conduct research works on the local raw materials so as to substitute the imported ones. According to Mohammed,(1984) funds should be made available for research purposes especially of the raw materials. Furthermore, Asuelimen,(1984) is of the view that "Local Raw Material Fund Campaign", should be lunched throughout the Federation.

Nigeria has a wide variety of domestic sources of dye as discovered by Eicher,(1976) since dyestuffs are part of the problems being faced not only by textile decorators, but also by textile industries, the researcher was moved to conduct this study. A similar research has once been conducted by Adetoro,(1972) and it

was on the basis of his opinion that there was need for future researchers to conduct a more thorough study which also attracted the researcher's interest on this study.

The study did not intend to frustrate the efforts of the traditional indigo dyers or those of craftsmen and women. The taste in textile is becoming very sophisticated and consumers are increasingly demanding goods of better quality and attractive colours. As Lesch,(1969) rightly points out "... The present generation of textile craftsmen is extrimely sensitive to colour". The traditional indigo dyers did not seem to meet this increased demand since indigo only produces shades of blue alone. More other attractive colours are therefore, necessary to be extracted from plants in order to meet this increased demand.

The study is concerned with how the problem of lack of dyestuffs faced by the home dyers, studio workers, textile scientists and artists and the Nigerian textile industry could be reduced. It is also the concern of this study

that factors influencing vegetable dyeing and dyes be correctly assessed. It further attempted to reduce the over dependence on the imported synthetic dyestuffs. This study was therefore, thought to be significant in that:

The availability of vegetable dyes will help the textile artists and technologists graduates from the Nigerian Universities and Polytechnics not to rely so much on the Government or the Textile Industries for employment. Those who wish can set up their own dyeing work-shops or studios which will eventually create job opportunity.

The Nigerian textile industry and textile decorators will have more dyes to work with. This will result in people retaining their jobs and trades, the problem of unemployment and retrenchment will eventually be reduced. Skills will also be acquired, workers and the textile industries will pay taxes to the government which will be used to provide services for the development of the society hence reducing some of the social problems.

The traditional indigo dyers will have more varieties of colours from other plants rather than depending on the indigo which only produces shades of blue. This will attempt to meet the increase demand of sophisticated textile goods by consumers. By producing dyes from the domestic sources for dyes, the study will also made an attempt to promoting one of the policies of the Federal Military Government, the concept of self reliance. And by cherishing and purchasing goods produced domestically, according to Onwumere, (1984) our economy will get a boost.

Factors influencing vegetable dyeing and dyes will be correctly assessed. This will enable those in the dyeing trade, textile artists and scientists, the textile industries and institutions of higher learning in the country to determine the quality and quantity of colour a dye-plant will yield in a certain geographical environment. This is also to enable them to determine the fastness properties of such dyes on cotton fabric. When these are achieved, the over dependence on the imported synthetic dyestuffs is reduced.

1.7 DEFINITION OF SPECIAL TERMS

Mordanting

When dyeing with most natural dyes, the fibre or fabric to be dyed has to undergo some special preparation or treatment. This is to enable the colour to be fixed on the fibre or fabric. This process is known as 'mordanting'. The word "Mordant" comes from 'mordere', a Latin word for 'bite'. According to Brown, (1978), the mordant seems to bite into the fibre making it possible for the dye to penetrate. And Bliss,(1980) reports that chemical bonding takes place between the fibre, mordant and the pigment from the plant, thus uniting the fibre during its stay in the dye bath. Most common mordants include alum, chrome, tin, copper and iron.

Mordant Dyes

These class of natural dyes are sometimes referred to as an adjective dyes. They have little or no colouring power in themselves. So the fabric to be dyed with these dyes has to undergo the mordanting process.

NOn-Mordant Dyes

(sometimes called substantive dyes).

Unlike the mordant dyes, non-mordant dyes give their colours directly to the fabric. The process of mordanting is not as important as with the mordant dyes. Example of non-mordant dyes are the ones got from the lichens.

Temperatures

(a) Room temperature in this study is ± 20°C to 27°C.

(b) Simmer temperature in the study is 64 - 70°C and

(c) Boiling temperature is 100°C

Cotton Fabric

The use of cotton in the study, refers to the white 'puplin' (plain weave) fabric which is easily available in the local markets. The cotton fabric in this study weighs approximately 150 grams per metre.

p^H

p^H is the degree of acidity or alkalinity of any solution.

1.8 LIMITATION

For the purpose of this study, muriatic acid, sodium carbonate, tannic acid and sumac leaves will not be used to mordant cotton fabric.

1.9 DELIMITATIONS

The study will be delimited to those dyes that can be extracted from plants and unless otherwise mentioned, any other dye from a different source is not included in the study.

The area in which the study will mainly cover is Kaduna State. The vegetation of the southern part of this state is more concentrated with a variety of plants than any other part. For this reason, most of the dye materials of the study will be from the south of Kaduna State. The area includes Kachia, Jama'a and part of Saminaka Local Government Areas. Bordering these Local Government Areas are parts of Plateau, Kano and Niger States. Since there is no clear boundary in vegetation, the study will also be extended to parts of some of these states, for instance Kano, Niger and Plateau. Areas of coverage therefore, include Kaduna, Plateau, Kano and Niger States.

1.10 BASIC ASSUMPTION

It is assumed that information collected from the samples will be a reflection of the true population from which the samples were chosen. It is further assumed that all official records and plants and fabrics studied in the laboratory or the field are authentic.

1.11 PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

The cotton material to be used in carrying out the tests of the study will first be identified by burnt test. Extraction of dyes and fastness tests will be carried out in the laboratory.

Collecting Dye Materials

As earlier discussed, natural materials differ according to climatic conditions and geographical locations. And according to Losch, (1969) the time of the year when the dye material is collected, and the growing condition of the plant determine the quality of colour that most vegetable materials contain. For this reason, therefore, time of collecting various dye material is as follows:

(a) Roots

Roots should be collected in late winter (October to March) when the sap is up.

(b) Freshy Seeds

This group of materials are best picked, when they are completely ripe.

(c) Stems and Veins

This group will be collected as late in the season of growth as the plant part is still in physical condition.

Dye materials could be used fresh or preserved by drying them in a well ventilated space and allow them to remain there until they are completely dry.

1.12 ANALYSIS

The analysis would be based on the results of the tests on the samples performed in the laboratory or studio. One can therefore, determine the quantity of dyestuffs needed to dye a certain weight of fabric and the amount of dye that could be extracted from certain quantity of dye plant. The acceptance or

rejection of a particular dye material by the samples of fabrics used and the degree of fastness of dye can also be determined.

1.12 SUMMARY

Chapter one states the introduction of the study as well as the historical background of this study. The chapter also contains the statement of the problem, purposes of the study and the significance of the study, the definition of special terms, the delimitation, basic assumption, the procedure for treatment and collection of data as well as the analysis were also stated in this chapter.

Chapter two will contain the review of the related literature. Chapter three will deal with the procedure for treatment and collection of data. Presentation and analysis of data will be presented in chapter four while chapter five present the summary, conclusions and recommendations for future research.

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CHAPTER - II

REVIEW OF RELATED LITERATURE

2.1 Introduction

2.2 Extraction of Dyes from Plants and Dyeing Procedures.

2.3 Effect of Geographical Environment on Colour Produced by Dye Producing Plants.

2.4 Mordanting of Fibres.

2.5 Colour Fastness Test.

2.6 Summary.

2.7 FootNotes.

2.1 INTRODUCTION

As mentioned earlier in Chapter One, there seems to be very scanty literature written on vegetable dyeing and dyes especially in Nigeria. Most research work on vegetable dyes and dyeing is carried out in either the United States of America or Britain. The applicability of findings of such studies to the local situation like Nigeria is therefore, questionable. The review of the related literature however,

will mostly be what has been done in the United States of America and Britain as well as other related places to the study. The areas to be covered are methods by which dyes can be extracted from plants, techniques of dyeing, effects of geographical environment, mordanting processes as well as colour fastness test to light and washing.

2.2 EXTRACTION OF DYES FROM PLANTS AND DYEING PROCEDURES

Brown,(1978) and Thurstan,(1949) report that plants which are to be used for dyeing purposes must be collected when they are young and vigorous. Flowers, for example, are best collected or picked just when they come to bloom. Leaves, they report, should be collected just when they are out in full and berries are best when they are a little overipe. Bark of trees according to them, should be gathered in spring otherwise in the fall. They also believe that roots are best dug in late summer and in fall.

Mustard,(1977) and Bliss,(1980) believe that the more plant materials put in the pot, the stronger the dye bath will be. This appears to mean that bath possesses stronger colours. They are also of the view that this does not necessarily mean that it will be brighter or last longer, but according to them, it is easier to dye with a stronger solution. That is, a shorter length of time is needed to get the colour with a strong solution of dye. Mustard further believes that plant materials should be chopped or broken into a pot and covered with water in order to extract dyes. This is brought to a boiling point and held there until the desired shade of colour is reached. She further reports that delicate blooms require only 15 minutes of boiling time and dry barks, might require three hours. The plant material she further believes, is strained out and enough water is added to make four gallons of the solution. The amount of dye property in that pot is believed to be the same, whether it is in one gallon or in four gallons of water.

According to Thurstan,(1949) the dyestuff is usually put into cold water and brought slowly up to boiling point and allowed to simmer slowly just below boiling point for varying periods of time before the fabric is immersed. Lesch,(1969) also reports that the process of extracting dyes from plants is done with boiling water but the process varies slightly. She believes that the dyestuffs are covered with water and the solution heated to boiling point. It is retained at this temperature until the desired shade of colour is achieved. When powders are used, Lesch believes that they are made into water-base pastes and allowed to set for different length of time before mixing with water. They are later heated to boiling point. It should be noted here that the length of time it takes for soaking and removing the colour depends, according to Lesch, on the type and condition of the plant. The length of time it takes for soaking the dyestuffs is not given by Murstard, (1977) and Thurstan,(1949) as earlier reviewed.

Bliss,(1980). also found that to extract dye from plants, the dye material ought to be covered with water and brought to simmer state ($180^{o}F$ - $190^{o}F$ or $64^{o}C$ - $70^{o}C$). This is done for about one hour. According to her, water can be added later if it is discovered that too much evaporates. She believes that one pound (.5 kilogram) of wool yarns is appropriate to obtain reasonable shades of colours. After the dye has simmered for one hour, she reports, the dye is allowed to cool with the plants in it before straining out the plant material.

To extract dye from plants, Adetoro,(1972) contends that the quality of the dye material required is put in water and soaked for a day. The soaked material is later heated for about two hours and the dye solution is allowed to cool. The material is then strained out. Roots and leaves, he believes, can also be boiled (after soaking) with an addition of strong potash until a desired shade is achieved. The dye solution, according to him, is allowed to rest overnight and strained out before the fabric is passed into it. Castino,(1975)

conducted a study and found that it is more appropriate for plants of any category to be soaked at least overnight. If the plant is fibrous, she further maintains, it should be soaked for at least three days to achieve optimum results. Walnut hulls (a common source of light brown) should be soaked from two weeks to a month, though she agreed that good results will be obtained with less time. After soaking, the plant material and its water according to her, must be cooked from one to two hours. This is similar to the study conducted on Walnut hulls by Brown,(1972) who also found out that after an overnight soaked of the wallnut hulls, it should be boiled for one to two hours.

Brown,(1978) contends that to extract dye from the roots of a plant known as beet, the whole plant should be boiled being careful not to break the skin. The skins should be removed and cut up the beets and covered with a solution of half water and half vinegar. It is allwed to stand for two days. The solution, she maintained, is then added to

the dyebath with a handful of salt. This is boiled with the yarn only for ten minutes. Further study conducted by Brown indicates that to obtain dye from a plant known as cochineal, the preliminary soaking of the plant is not necessary. The powder is added directly to the dyebath and heated with the wool very gradually. After soaking madder over-night, Lesch,(1969) and Brown,(1978) believe that this should not be boiled since, according to them, high temperatures tend to turn the colour to yellow. The temperature ought to be brought to 140 degrees and held for fifteen minutes. Wool is then immersed and instead of boiling the wool in the dyebath, it should be kept at approximately 190 degrees.

In the actual dyeing procedures, Bliss, (1980) and Lesch,(1969) conducted a study and found that the fabric should be thoroughly wetted before being put into the lukewarm dyebath. They also found that the temperature of the dyebath should be raised to a simmer ($180^{o}F - 120^{o}F$).
This temperature, they believe, should be

maintained about twenty minutes for light shades of colour and thirty minutes for dark shades of colour. Mustard,(1977) also agrees that the temperature of the dyebath ought to be slowly raised to a simmer but she is of the view that this should take forty minutes and one hour for tin (stannous chloride) mordant. When the fabric is "done", she maintained that it should be left in the dye solution to cool for best result. This is especially true on cotton fabric. According to her, there is always the chances that there will still be some colour left in the pot. So, more mordanted material may be dyed in this to give lighter shade of colours.

Thurstan,(1949) reports that there are three ways in carrying out vegetable dyeing. These are:

1. The fabric is previously mordanted and then dyed in a separate dyebath. According to her, red and yellow colours do very well with this method.

2. The mordant and dye are in the same bath; and

3. The fabric is dyed first and colour fixed afterwards. This process, she reports, is called stuffing or saddening and generally used with dyes as Kutch, or sometimes Logwood. This method also tends to darken and dulls colours as a rule, but makes them extremely fast, she maintained.

Dyeing, according to Thurstan, should continued until the desired shade is reached. It is difficult, according to her, for a beginner to match shade at first, and it should be remembered that fabric looks darker in the dyebath than after it is washed and dried. For certain colours, she believes that a hot soap bath is a great improvement as it brightens and sets the colour.

Lesch,(1969) and Thurstan,(1949) report that tartaric acid and Glaubers' salts are part of the standard recipes for dyeing fabric or yarns. Tartaric and the commercial cream

of tartar, they maintained, give the same results and it is used to make bright clear colours. If yarns are dyed without it, they lack luster. The Glaubers' salts, according to Lesch,(1969) are used as levelling agents; the salts exhaust the colour from the dyebath and make for uniform dyeing. If Glaubers' salts are used, Lesch believes that it is unnecessary to constantly stir the bath while the fabric is dyeing.

Other methods of extracting dye from plants and dyeing techniques in the related literature include:

1. Solar dyeing
2. Top dyeing
3. Economizing dyeing

Solar Dyeing

This is a technique employed by Bliss, (1980) using the heat and light from the sun to produce dye from dye producing plant. The plants in a glass jar is filled with water, the lid lined with plastic or waxed paper to avoid adverse metal contamination. The

jar should be set in a reflector which is made by cutting the top and one side off a cardboard box lined with metal foil. According to her, the box should be placed in the sun. With the aid of a mirrow or two, the water can be heated to boiling point. Mordanting and extraction of dye from plants processes can be carried out by the above method except using sun for heat source.

Top dyeing

Top dyeing according to Bliss,(1980) simply means putting an already dyed fabric through a second dyebath. In this case, no further mordanting is necessary, and when yellow fabric is put through a red bath for example, the result is orange.

Economizing dyeing

Mustard,(1977) believes that vegetable dyeing seasons are short. This is only true when one wants to dye with fresh material. One gathers what one can and prepare it into a dye solution. Then freeze it. She further reports that when more of the plant is

available, one should also freeze it. She believes that two batches will make enough for a big pot. If what is gathered is to be used for longer period, the second batch is boiled, making it extra stronger. A pot-ful of the dyestuffs is boiled and later the premordanted wool is immersed.

2.3 EFFECT OF GEOGRAPHICAL ENVIRONMENT ON COLOUR PRODUCED BY DYE PRODUCING PLANTS

Plant dyes, according to Bliss,(1980) produce varied results from one dyepot to the next. She continued by stating that usually, the most intense dyes will result from use of freshly picked plant, and they are best gathered when they are at the pre-blooming or blooming states. According to this source, a plant gathered from a dry area gives a more intense dye than the same plant from a wet area. This assertion is supported by Lesch,(1969) who believes that natural materials (for dyeing) differ according to climatic conditions and geographical regions. The time of the year, she continued, when the dye material is collected, and the growing conditions of the

season, determine the quantity of colour that most vegetable materials contain. Berries, bark of trees, fruits, seeds and must have a lot of hot sun-shine to produce strong dye colours. She reports that hot but not too dry weather produces the best colours. Materials, according to her, should generally be cut as late in the season as possible and when it is in peak growth condition.

Lyttle, (1974) also asserts that plants vary from one region to another. Even, he continued, those of the same species can give different result due to climate, soil, or a combination of both. Bliss, (1980) believes that the chemical make up of the soil where the plant is gathered can affect their dye colour. Bliss is of the opinion that the p^H of the soil also affects the p^H of the plants and thus, it affects the dye results. The time of the year and climate as well as the altitude and amount of precipitation, she believes, can cause the dyebath to give unexpected results. Castino (1975) also affirms that the same plant material taken

at different seasons may produce different colours, and according to her, some may produce no dye at all at the wrong time of the year.

Mustard,(1977) is of the opinion that the pH of the water used in vegetable dyeing will help determine the colour of the plant. Rain water, she believes, is supposedly the best type of water to dye with and a small amount of water softener is added if the water is hard. But one might want to experiment with both hard and soft water for the effects. Bliss,(1980) also reports that if water from the well is used, it may contain minerals that could darken, as iron does, or otherwise change the colour produced. The pH reading, she continued, or relative degree of acidity or alkalinity of the water will also affect the dyebath. Most plant dyes are acidic, so that if the water is alkaline, variant shades are expected from those obtained with neutral or acidic water. Water and the type of yarn used, she concluded, may also vary the results of dyeing.

Lesch,(1969) and Lyttle,(1974) also report that soft water is best for most of the processes of vegetable dyeing, but it is not absolutely necessary, according to them. In order to make a fairly efficient water softener, Lesch,(Pg. 16, 1969) gives this suggestion;

> ... dissolve one pound of washing soda in a one quarter of boiling water. Stir this until it is completely dissolved. If the water is moderately hard, add two table spoons of the solution for each gallon of water. A water softener made this way can be bottled and kept almost indefinitely.

Thurstan,(1949) also reports that every kind of plant from which dye is obtained is a product of geographic environment, the quality of which depends on climatic, soil, water and other conditions. Thus, a plant in the North of Nigeria may produce a better dye than the same plant in the South, and vice versa. She also reports that the same plant may give a different shade of colour if gathered at different periods of the year, while Castino, (1975) believes some may produce no dye at all.

2.4 MORDANTING OF FIBRES

Castino,(1975); Lesch,(1969) and Thurstan, (1949) report that mordanting of textile fibres is very important to successful vegetable dyeing. They also believe that mordants are metallic salts which produce colour ranges peculiar to the particular kind of metal from which the salt is made, i.e., different mordants produce different shades of colour from the same dye plant. Lesch,(1969) and Mustard,(1977) also believe that mordant change the chemical bonding structure of the fibre molecule, allowing the dye to actual become part of the molecule itself. As a result, they further report that the dye is there permanently, as opposed to a stain that is only on the surface of the fibre. Bliss, (1980) and Castino,(1975) believe that in the early days (up till the mid-nineteenth century) all mordants came from the earth in the form of alum and various metal compounds. Some were got from sea, salts and from plants came natural tannic acid in bark, nuts and roots. Others were from vinegar extracted from

grapes. Today, however, most mordants are metal based, they concluded.

In mordanting one pound of wool, Castino, (1975) used the following measurements of individual mordants to three gallons of water.

3 ounces alum combined with 1 ounce of tartar.

1 table spoonful chrome.

3 ounces copper

3 ounces iron

2 ounces tin

1½ cups of salt

6 cups of vinegar

(sizes of cups not given)

In a glass or enamel cup, the mordant is dissolved in a little warm water (vinegar according to her can be added directly) and the solution is poured into the pot of mordant. The bath is then heated to lukewarm and the fleece is added to it. The bath is brought to a boil and then quickly turned down to simmer. The fleece is simmered for one hour. The fleece is allowed to cool a little, the fleece then removed and rinsed in hot water. If

chrome is used, a lid should be kept on the pot during the entire mordanting process, this is because, according to her, chrome is sensitive to light and its fumes are poisonous.

Mustard,(1977) believes that wool is the easiest of all fibres to dye with vegetable dye. To prepare one pound wool yards, some soap flakes are dissolved in water which is hot as one's hand can stand and according to her, the wool is allowed to sit in it for half an hour. The wool, she reports, is squeezed once or twice and the water is allowed to drained out. For the actual mordanting process, a large pot with about four gallons of water is needed. The mordant is dissolved in some boiling water and the mixture added to the large pot and stirred. The wet wool is then added, making sure it stays below the surface of the water. The temperature of the pot, she continued, is slowly raised to simmer. This should take a quarter of an hour and one hour if tin mordant is used, she maintained.

Lesch,(1969) believes that vegetable fibres normally have less affinity for vegetable dyes than animal fibres, and they do not dye well. So, like Mustard, most recipes given by Lesch are for a pound of pure wool yarns. In preparing the wool yarns for mordanting process, three gallons of water is used to scour one pound of dry wool fibres. She believes that water softener should be added to the water until the water is slick and soap is added until mild suds are formed by stirring. Wool is then immerse and simmered for about 45 minutes. To make a solution for a mordant, she continued, three gallons (Mustard used 4 gallons) of water is usually enough. The mordants, according to Lesch, may be mixed with water to form percentage solutions, or they can be measured by a spoonful. In her own mordanting procedure, vegetable fibres stayed longer in the mordant bath.

Bliss,(1980) asserts that though cotton and other vegetable fibres can also be dyed with plant dyes, they require more extensive

mordanting procedures. This is unlike wool which can usually take most vegetable dyes with enthusiasm. She believes (like Mustard and Lesch) that cotton material require a three step mordant which are alum, tannic acid and another alum bath. She reports that there are three successful methods to be employed in vegetable dyeing. These are to mordant before, during and after the yarn is in the dyebath. To prepare the mordant bath, Bliss dissolved the mordant in water by adding the chemical (mordant) to water. The bath is brought to a simmer ($180^{0}F$ - $190^{0}F$ or $64^{0}C$ - $70^{0}C$) and kept simmering for 15 minutes. After the mordant is dissolved, she warmed up the water containing the clean wool until it was very hot. The water is drained off the wet wool is put in the mordant to simmer for one hour. The bath is then removed from the bath and the yarn remains in the mordant bath to cool. She sometimes gives an after-bath of a second mordant and this is given primarily to change yarn colour after it has been dyed, by the effect of the mordant's colouring or shading ability. This is done after dyeing

by preparing the second mordant bath and simmering the dyed yarn for as little as 15 minutes prior to a final rinsing.

The following are the amount per pound of dry, clean wool used by Bliss:

Alum – 4 table spoons (64 grams) per pound.

Chrome – 3 tea spoons (20 grams) per pound.

Copper – 2 table spoons (42 grams) per pound.

Iron – 2 table spoons (27 grams) per pound.

Brown,(1978) believes that it is best to mordant prior to dyeing. And because of its sensitivity to light, chrome is best used to mordant immediately before dyeing. Iron to her, is best added to the dye bath toward the end of the dyeing so as not to harm the fibre unnecessarily. For a pound of wool yarns the following mordant formulae were used:

4 ounces alum (slightly less than ½ cup)
1 ounce cream of tartar (about 2 table spoon)

4 gallons of soft water.

It should be noted here that the volume or size of cup Bliss used is not given.

The alum and cream of tartar are dissolved in boiling water (about 2 cup ful). Four gallons of water is added. The wetted wool is entered and heated gradually and stirred often. This is simmered gently for about an hour, poked and stirred occassionally. It is cooled and allowed to stand in the mordant bath. Excess moisture is squeezed out and stored in towel, or dried for future use. Procedures to mordant with tin, Brown employed the following:

½ ounce tin or 1 table spoon.

4 gallons soft water.

Same procedure was used as with alum. Here, however, she cautioned that the wool should be washed and rinsed and used immediately. In order to brighten, or "bloom", colours mordanted with other chemicals, she is of the opinion that tin can be added to dull the colours. To mordant with copper, the same procedure as with tin is employed. In

mordanting a pound wool with chrome, she suggested that this must be done just prior to dyeing, since, according to her, chrome is sensitive to light. Everything possible must be done to keep the mordanted wool away from light. The procedure for mordanting wool with chrome is as follows:

½ ounce chrome or slightly less
than 2 tea spoons.
4 gallons soft water.

This is proceded as in mordanting with alum. She used a ceramic plate to put on top of the wool in the mordanting bath to keep it under water. A lid is used on the not also. The wool in the pot is kept until one is ready to transfer it quickly to the bath.

Mustard,(1977) believes that cotton fibres are of vegetable origin and so are composed mostly of cellulose. Straingely enough, it is quite difficult to dye them well with vegetable dyes. Mustard employed the following procedures in order to scour and mordant cotton:

2/3 cup of alum.

2 tea spoons sodium carbonate
(washing soda)
1 tea spoon tannic acid, or a large
double hand-ful of sumac leaves.

Water, in an enamel pot.

1/3 cup of alum is dissolved and 1 table spoon washing soda in some boiling water and stir it into 4 gallons of water. Wet cotton material is added. This is boiled for an hour and then allowed to remain in the pot until the next day. The excess liquid is squeezed out and rinsed. Sumac leaves were put into a pot and a gallon of water was added. This was boiled for one hour, the leaves were strained out. Cotton material was allowed to sit in the bath over-night, rinsing it out the next day. She finally dissolved the remining 1/3 cup of alum and one table spoon washing soda in the same more boiling water and added it along with the cotton to another 4 gallons of water. This was boiled for one hour and allowed to cool over-night before rinsing. Cotton fabric which is taugher than the yarn,

was boiled for a half hour in muriatic acid for each gallon of water. Mustard believes that this acid (muriatic) will take off that impervious finish on cotton fabric and allow mordant to work. After the muriatic acid bath, the tannic acid-alum mordanting was finally employed. The cotton fabric is then ready for dyeing.

According to Thurstan,(1949) there are several methods of preparing cotton fibre to accept vegetable dyes. She presents one method:

1. Boiling

   Boiling for at least an hour in water with a little soap or soda in it. She believes that this is to cleanse it throughly. After boiling, the cotton fibre is left steeping in the solution for twenty-four hours.

2. Galling

   The cotton is steeped in a strong astringent solution such as tannic acid, 1 ounce to 1 pound. This was

brought to boiling point and allowed to simmer for an hour. The pot is taken off the fire and the cotton is allowed to get cold in the solution.

5. The cotton fibre is removed from the galling solution after several hours' steeping and wash.

4. <u>Aluming</u>

This process should according to her, be done as for wool, but cotton should be left soaking in the alum solution for several hours.

This method is similar to the one employed by Mustard but here the fibres undergo acid treatment before aluming. In the former method (Mustard's) the fabric or fibre had to be subjected to treatment for more than 24 hours before it was ready for dyeing. The method also involves a lot of heat enemy, something which everyone would like to avoid. Mustard's method of scouring and mordanting cotton can be followed closely, by allowing the material to be subjected to five boils at five

different times. It is believed that long or constant boiling of this material will definitely weaken it.

To mordant cotton fabric, Meilach,(1973) confirms that the fabric should be washed in hot detergent water, rinsed and dried. According to him, fabric ought to be tied before mordanting and placed in a deep pot with enough solution to cover it. He is of the opinion that after mordanting, fabric should not be rinsed, because, according to him, the degree for accepting dye is reduced. His mordant procedures for one pound cotton is as follows:

4 ounce alum

¼ ounce washing soda (sul soda)

4 gallons soft water (add calgon to water).

The fabric in the solution is boiled for one hour and allowed to stand over-night. This procedure of scouring and mordanting cotton is more agreable than methods employed by Mustard,(1977) and Thurstan,(1949). Method employed by Meilach involves little heat

energy application and the use of chemicals is minimised. As far as the related literature on scouring and mordanting is concerned, alum is known to be the only mordant used to mordant cotton material. The related literature so far also reveals that mordanting process is being carried out at a boiling point temperature, that is, in most cases, at over $180^{o}F$ - $190^{o}F$ or $64^{o}C$ - $70^{o}C$.

2.5 COLOUR FASTNESS TEST

Testing vegetable dyes for fastness, Brown,(1978) believes that the most important tests for these types of dyes are for light and washing. Test for light fastness is carried out by putting a small swatch of the dyed yarn in direct sun light and after a week this is compared to the rest of the skein, which has been kept away from the sun entirely. She believes that dyes from tree bark (which have tannin) will actually darken when exposed to sun light. Test for washing is done by washing a small amount of the dyed yarn in hot water and soap along with some white wool yarn. If the white yarn becomes stained with

the colour, one will know just how much the colour bleeds.

Bliss, (1980) reports that only light fastness test is necessary in vegetable dyeing. To test the dyed material for fastness to light, a piece of mat board or comparable cardboard is inserted in the folded card with part of it protruding and part enclosed within the folded card. The carded yarn sample is exposed to direct sun-light, preferably at 45° angle facing the sun. After a length of time which may be 40 to 100 hours, the card can be opened and by comparing the exposed section of the yarn with the unexposed section, one observed that there is a certain amount of fading. Mustard, (1977) also believes that only test for light is necessary in vegetable dyeing. This is done by taking a small amount of dyed material, completely covering half of it and putting both portions on window still in strong sun light. In a week, she continued, the uncovered area is opened and one can see how much colour change there is.

2.6 SUMMARY

Chapter Two dealt with the related literature of the study. The methods by which dyes could be extracted from plants as well as the dyeing procedures were reviewed. The effect of geographical environment on colour produced by dye plant, the mordanting process for fibres and the colour fastness test for light and washing were also reviewed in this chapter.

The available literature reveals that every kind of plant from which dye could be obtained is a product of geographical environment. That is to say, its quality depends on climate, soil and water. The literature also reveals that natural dyes demand natural fibres and wool is the easiest of all fabrics to dye with vegetable dyes. It further reveals that cotton fibres do not easily absorb vegetable dyes.

Mordanting procedures in the literature indicate that mordanting is carried out at simmer temperature. It also reveals that

method by which dyes can be extracted from plants is by raising the temperature to about 180°F - 190°F or 64 C - 70 C, for thirty minutes to one hour, after a certain length of soaking time. The related literature reveals that only light and wash fastness tests are necessary in vegetable dyeing. Light fastness test is done by exposing a piece of dyed material to direct light for two to seven days by which the dyed material is compared with the same one not exposed to light. Wash fastness test is done by washing the dyed and white yarns together. The amount of stain on the white yarn determines the degree of fastness the colour is.

Procedures for collecting and treating the data of the study will be presented in chapter three.

2.7 FOOTNOTES

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CHAPTER - III

PROCEDURES FOR COLLECTION AND TREATMENT OF DATA

3.1 Introduction
3.2 Population of the Study
3.3 Experimental Procedures
3.3.1 Mordanting Procedures
3.3.2 Dyeing Procedure
3.3.3 Colour Fastness Tests
3.3.4 The Dye Plants
3.4 Summary.
3.5 FootNotes.

3.1 INTRODUCTION

This Chapter of study presents the method and procedures used in the selection, collection and treatment of data. Areas discussed are the population of the study, the procedures for general mordanting and dyeing processes and the colour fastness tests. The dyeing procedures, method of collecting and preserving, as well as the amount of dye possible for extraction and result for each dye producing plant are also discussed.

The study was designed to provide some practical information on vegetable dyes and dyeing. Thus the following procedures as well as experiments were employed:

1. Plants from at least two different geographical locations (Kura, Minna, Zaria, Kafanchan and Manchok) of same species of dye producing plant were collected.

2. Ways by which dyes could be extracted from certain species of plants.

3. Tap water and Well water were used in carrying out the dyeing procedures.

4. Six different mordants were tried on each dye producing plant.

5. Some quantity of dye was extracted from each dye plant.

6. Tests for colour fastness to light and washing, were carried out in the study.

3.2 POPULATION OF THE STUDY

The population of interests comprises three dye producing plants namely turmeric, bixa and onion skins. The roots of turmeric were dug

and were washed, the water was allowed to drain out. They were later smashed and used fresh or spread indoors to dry for future use. The pods of bixa were collected and opened to expose the seeds which were used for the dyeing purpose. Onion skins were collected from the local onion sellers in the market. The skins were further spread to remove foreign materials like stones, decayed onions, papers.

Areas in which the study covered included: Niger, Kano and Kaduna States of Nigeria. The choice of these states were found necessary because of their different geographical locations. In order to determine the effect of mordants on vegetable dyeing, six different mordants, alum, chrome, iron, tin, copper and wood ash, were tried on each dye plant. The effect of mineral cotents of type of water used in carrying out the dyeing process in the study. Tap water and well water can easily be got than rain or snow water. Cotton fabric (white) is more easily available in most of the local markets than any other class of fabric. For this reason, cotton (white) fabric was used in carrying out the tests of the study.

3.3 EXPERIMENTAL PROCEDURE

As earlier stated, part of the design of this study was aimed at providing some practical information on vegetable dyes and dyeing. In order to achieve this objective, the study was divided into the following areas of operations:

3.3.1 Mordanting procedure

3.3.2 Dyeing procedure

3.3.3 Colour fastness tests

3.3.4 The dye producing plants

3.3.4.1 Bixa

3.3.4.2 Tumeric ('gangamau' or 'magina')

3.3.4.3 Onion Skins ('albasa')

3.3.1 MORDANTING PROCEDURE

When dyeing with most natural dyes, the fabric or fibre to be dyed has to undergo some special preparation. This is to enable the colour to be fixed on the fabric or fibre. This is because, according to Storey, (1978) most natural dyes (including vegetable dyes) with very few exceptions, have no colouring power except when they are used in conjuction with mordants. Losch, (1969) and

Thurstan, (1949) also believe that the success of vegetable dyeing rests chiefly on the mordanting procedure.

The most common class of fabric found in the local markets is the white cotton fabric especially the one known as 'poplin' and for the purpose of this study, the use of fabric has been controlled. As a result, cotton fabric has been used. A test of this cotton material was done by burning a piece of it and it burnt with a smell resembling charred paper. The cotton fabric was first scoured to rid it of all impurities and dressing. Mostly, these are size added to the warp yarn as a preliminary to weaving. The grease content during finishing if not eliminated, repels dye.

The use of muriatic acid, sodium carbonate, tannic acid and sumac leaves by Mustard, (1977) and Thurstan, (1949) to mordant cotton fabric as revealed in chapter two was not used in this study. This was because these chemical were not included in the study as stated in chapter one. For the purpose of

the study therefore, the cotton fabric was scoured by soaking it into a soap solution and boiling it for two hours. Two hours boiling was assumed to be enough for washing and cleaning the fabric thoroughly. The fabric was allowed to cool in the soap solution before it was washed and rinsed in clean cold water. It was later hung to dry, ready for the actual mordanting process.

Lesch,(1969) believes that mordanting process can be carried out in three ways:

i. Fabric mordanted before dyeing
ii. Fabric mordanted while dyeing
iii. Fabric dyed before mordanted.

Mordanting before dyeing was found to be more convinient and appropriate in the study. It is also the most popular method in vegetable dyeing and according to Thurstan, (1949) the method makes the colour extremely fast. Unless therefore, indicated, this method was mostly employed in the study. The related literature of the study revealed that mordanting procedure was carried out at boiling temperature. It was on this basis

that the need to determine the effect of temperature and time on mordanting procedure was necessary. Mordanting was therefore, carried out at room and boiling temperatures. In order to determine the effect of time on mordanting procedure, the time in which samples stay in the mordant solution varied from five to 120 minutes. When mordanting started at 12 noon for example, it ended at 2.00p.m.

Various mordanting properties were tried and the following ingredients were found to be more appropriate:

i. One tablespoonful mordant
ii. 10 grams fabric (samples)
iii. 400 ml. of water
iv. 800 ml. stainless glass beaker

The use of stainless glass beaker was found necessary in this study because unlike the iron, brass or copper pots, beaker stainless steel cause no chemical reaction to the water. For this reason, the true colour of the dye is not affected.

Boiling Temperature Mordanting

The mordant (in powder form) was dissolved in warm water. When the mordant was well dissolved, the samples to be mordanted were wetted and later added to the mordant solution (wetting helped in level mordanting). Temperature was raised to boiling point and time was taken. As mentioned earlier, the control time for mordanting was two hours. That is, after five minutes that the samples has stayed in the mordant solution, two samples were taken out, squeezed and rinsed. Other samples were removed after 10, 30, 60, 90 and 120 minutes interval as stated before.

Room Temperature Mordanting

The same procedure was used here as that of boiling temperature except that the mordant was dissolved by continuous agitation. In the case of alum mordant which was solid, it was crushed into smaller particles for easy dissolution both in cold and hot water and also for accurate weighing. Mordants tried in the study included:

1. Alum (potassium aluminium sulphate)
2. Wood ash
3. Chrome (potassium dichromate or bichromate)
4. Copper (copper sulphate)
5. Iron (ferrous sulphate)
6. Tin (stannous chloride)

The chemical composition of wood ash - an aqueous solution of wood ash has been found to have a p^H of 9 - 9.2, hence it is alkaline, Noah (1985).

The wood ash tried in the study was that of mahogany tree which was gathered from Jama'a Local Government Area of Kaduna State. Fire was set to the dried wood and allowed to burnt out completely. The ash was allowed to cool then sieved to a fine powder. The wood ash was used in the same manner as other mordants in the study.

3.3.2 DYEING PROCEDURE

Tests as contained in sample 111184, Plate I, were carried out and the following dyeing ingredients were found most appropriate to be employed in the general method of dyeing procedure of the study. They were as follows:

No Mordant
30 minutes hot dyeing

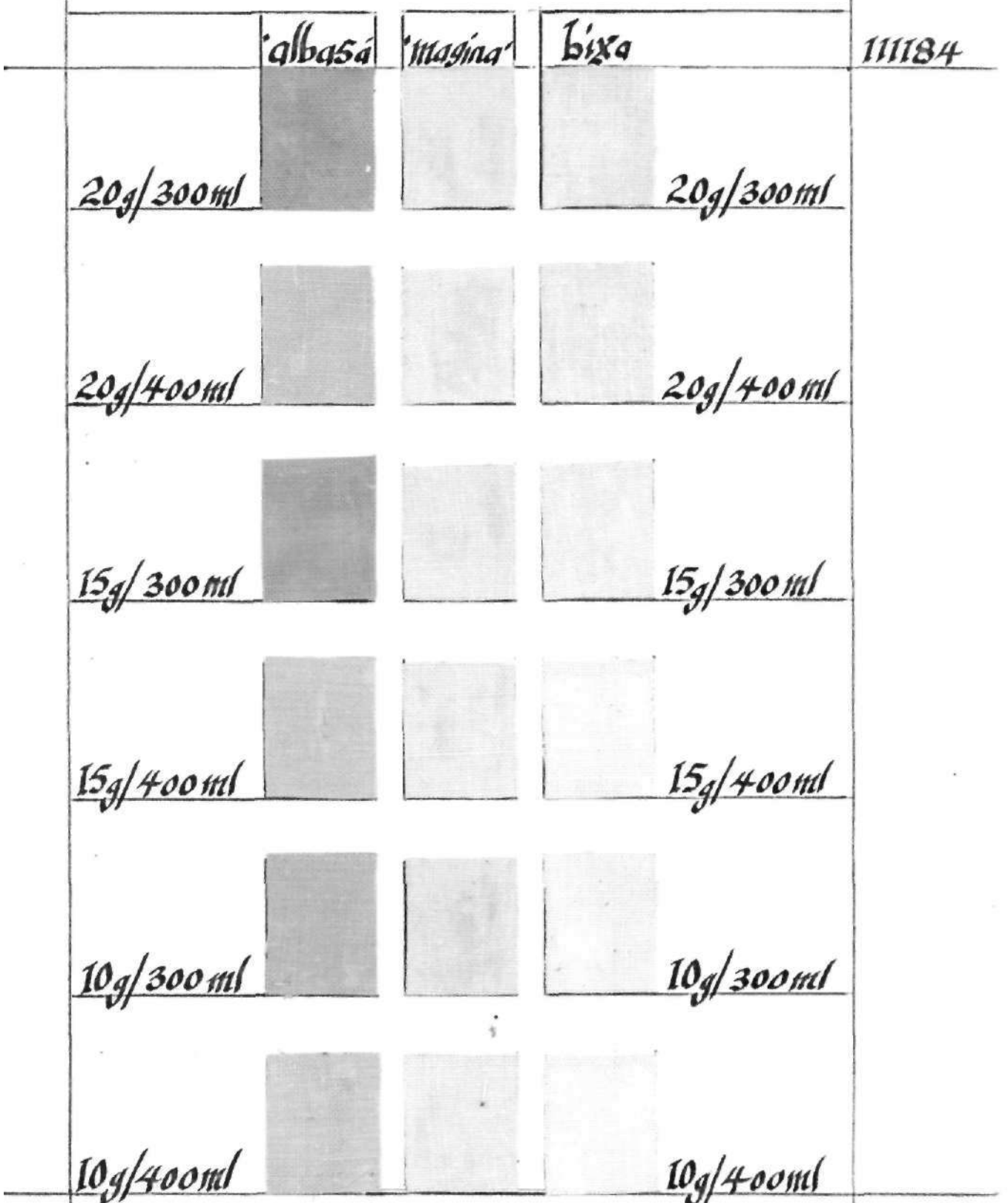


Plate I: Dyeing Ingredients

i. approximately 7 grams samples (fabric)
ii. 10 grams dye material (plant)
iii. 300 ml. cold water
iv. 800 ml. stainless beaker

Preparing the Dyebath and Actual Dyeing

The liquid in which the dyestuffs or materials were boiled was lukewarm. When the samples were entered into the liquid the samples were covered completely. The dye plant was first chopped or smashed (as in the case of 'magina') into pieces. Chopped or smashed plants did not necessarily yield better dyes as discovered by Mustard,(1977) and Lesch,(1969) but chopping or smashing helped bring out the desired colour in a shorter length of time. Chopping also for the purpose of the study helped in accurate and easy weighing of the material.

The smashed dye plant was covered with cold water (10 grams of dye material to 300 ml. of water). This was allowed to be soaked for a period of two to twelve hours depending on the type of the dye material. For instance, fresh bixa seeds were soaked for two hours, dried

seeds were soaked for six hours, turmeric ('magina') fresh roots were soaked for six hours while the dried turmeric were for 12 hours and onion skins ('albasa') were soaked for six hours. After soaking, the material was boiled for 30 minutes as also agreed by Lesch,(1969). The material was allowed to settle and was later strained. In the actual dyeing, hot and cold methods of dyeing were employed.

i. Hot Method of Dyeing

The actual dye solution with the effect of evaporation during boiling, always reduced to approximately 250 ml. (of dye solution). Water was added to make up to 300 ml. to be able to cover the 7 grams samples. The samples were then entered and temperature was gently raised to boiling point and time was taken. The temperature was maintained for 30 minutes. For level dyeing, samples were wetted and agitation was done frequently throughout the dyeing period. The samples were taken off from the heat and allowed to rest in

the bath to cool down before they were rinsed in clean cold water and dried out in direct sun light.

ii. Cold Method of Dyeing

The procedure as in hot method of dyeing was also employed here. That is, after the 30 minutes boiling of the soaked material it was strained out. The samples were entered. Addition of water was not necessary and dyeing took place at room temperature.

3.3.3 COLOUR FASTNESS TESTS

Among the principle properties which all dyes must posses is fastness, that is, the ability to withstand the daily activities such as washing, light, rubbing, etc. Testing of vegetable dyes for fastness, Brown,(1978) believes that the most important tests for these dyes are for light and washing. Bliss, (1980) also believes that only light fastness test is necessary in vegetable dyeing. However, for the purpose of this study, only tests of fastness to light and washing were

carried out. This was on the assumption that if vegetable dyes can withstand light and washing, it can also withstand other daily activities such as rubbing.

i. Light Fastness Test

Light fastness test was done by exposing some dyed samples in direct sunlight for three days and was compared with the ones of the same pieces which had received no light.

ii. Wash Fastness Test

Dyed samples were mounted on white pieces of fabric of the same size. These were put into a container of 50 ml. soap solution (five grams of soap to one litre of water). The samples were then washed in the washing machine at 50°C for a period of 45 minutes. The samples were rinsed in clean water and dried. They were compared with the dyed samples that have not undergone the process of washing. For each dye plant, dyed samples which did not undergo mordanting process were also tested for colour fastness. For the

results of mordanting, dyeing and colour fastness procedures, the individual dye plants will be discussed.

3.3.4 DYE PLANTS

3.3.4.1 BIXA

Bixa is a shrub or small tree introduced from tropical America in West Africa. According to Delzid,(1936) some tribes apply Bixa like camwood as cosmetic for colouring the face in folk dances, or for staning utensils, cotton, etc.

i. Collecting and Preserving the Dye Material

For the purpose of dyeing, the seeds of bixa shrub were used. The pods containing the seeds can be picked or gathered when they are mature, usually as from October to January. The pods were opened to expose the seeds. The seeds can be used fresh or can be preserved for future use. In order to preserve the dye material, the seeds were removed and spread out indoors for about two weeks (this depends on the weather condition). They were tied in

paper bags to be kept in a dry place with a label indicating where and when the material was gathered.

For the purpose of the study, this dye materials were collected or gathered from Manchok, Jema'a Local Government Area and Samaru - Zaria, all in Kaduna State. The choice of these two areas were necessary because of their different geographical locations and also the availability of the dye material in the areas.

ii. <u>The Dyebath and Actual Dyeing Procedure</u>

As earlier discussed in this chapter, 10 grams of the dye specimen (material) was covered with 300 ml. of cold water. The fresh specimen was soaked for two hours. The specimen was then boiled for 30 minutes and allowed to cool down. The material or specimen was strained out and the samples were entered and dyed for 30 minutes. The samples were allowed to settle in the dyebath before they were rinsed in clear cold water and dried.

iii. Amount of Dye Possible for Extraction

20 grams of the bixa seeds were covered with 150ml. of water. The fresh seeds were soaked for two hours and boiled for 30 minutes. The specimen was allowed to cool down and later strained out. What was got was a highly concentrated dye solution. This was left in a glass tray for about one week depending on weather condition. After evaporation, a powder deposit was left. This was the amount of dye powder possible for extraction. Therefore, 20 grams of the fresh dye material appear to be capable of producing about seven grams of fabric (approximately one metre). About one kilogram of the fresh material is estimated to be possible for collection in this area of the study.

iv. Colour Fastness

Without the use of mordant, the results obtained from bixa showed some fading effect as contained in samples (7685(B), plate II and sample 5685(B), Plate III. The resultant colour was more fast to light and washing when tin mordant was used as shown in samples 121284 (B, E and H), Plates IV, V, and VI.

No Mordant From top to bottom: 5, 10, 30, 60, 90 and 120 minutes hot dyeing			30 minutes hot dyeing. Boiling temperature mordanting			7685
(A)	(B)	(C)	(D)	(E)	(F)	
						– Iron –
						– Tin –
						– Chrome –
						– Copper –
						– Alum –
						– Wood Ash –
'albasa'	bixa	'magina'	'albasa'	bixa	'magina'	

Plate II: No Colour Fastness Test

v, Results

Without the introduction of mordant to cotton fabric, bixa dye plant produced light pink. When various mordants were introduced to the fabric, the colour varied from light pink to dark pink and brownish colour under the same dyeing condition. Wood ash, tin, chrome and alum mordants produced almost the same range of colours. Wood ash and tin mordants produced a deeper orange- pink then chrome and alum all under the same dyeing condition. Iron mordant produced between grey and brawn colour while copper yielded light khaki colour as contained in sample 7685 (I), plate III.

Dried material was also used and it was observed to have produced darker shades of colour than when fresh materials were used. This is especially true with the use of iron mordant. That is, the difference in shade between the fresh and dried materials was more pronounced with the use of iron than wood ash and tin as contained in sample 30485, plate VII. There seemed to be no difference between room and boiling temperatures mordaning as well as mordanting time in the final

No mordant

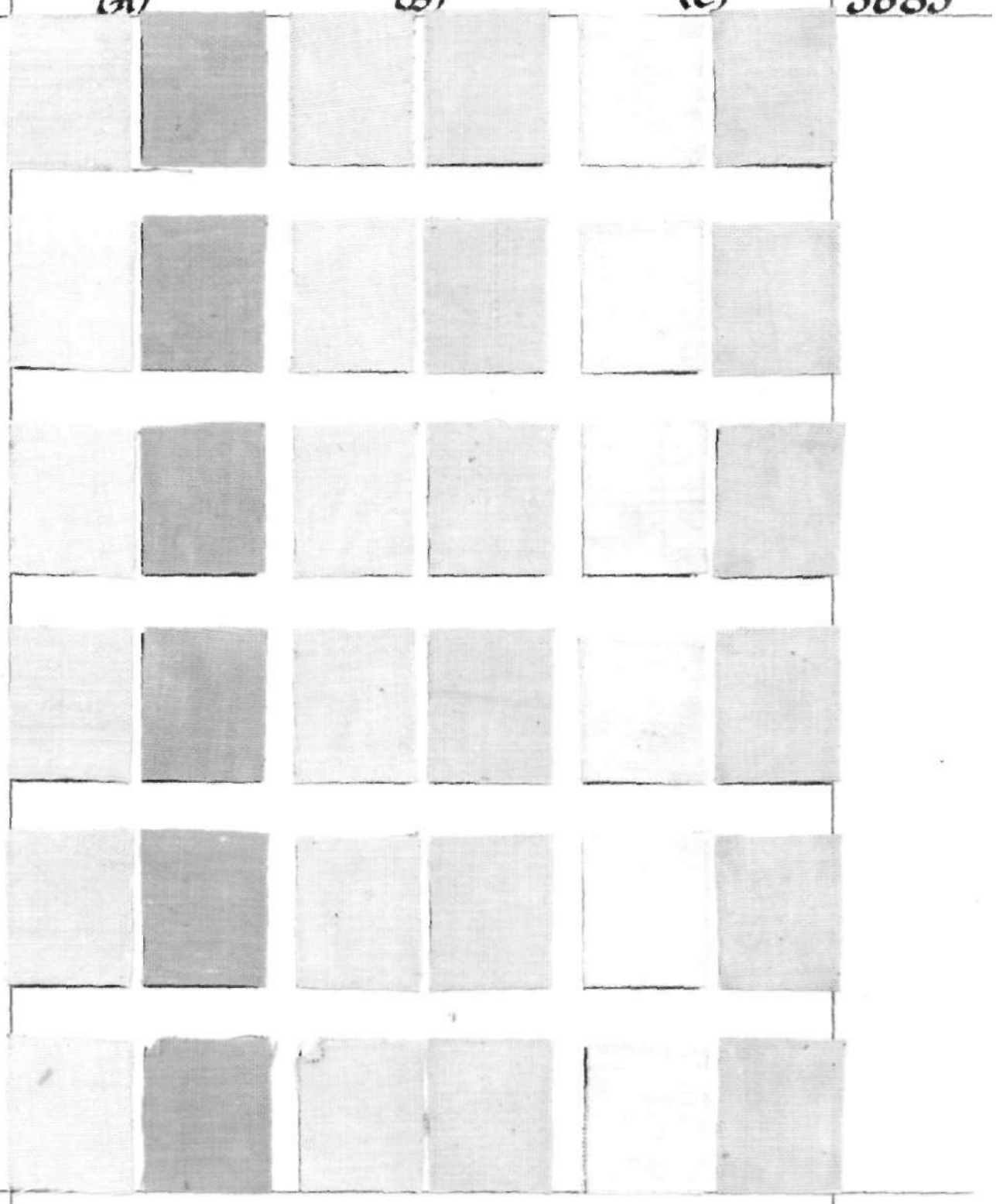
From top to bottom: 5, 10, 30, 60, 90 and 120 minutes hot dyeing

Tested for Wash and light fastness

85

5685

(A) (B) (C)



'albasa' | | bixa | | 'Magina'

Plate III: No Mordant. Colour Fastness Test.

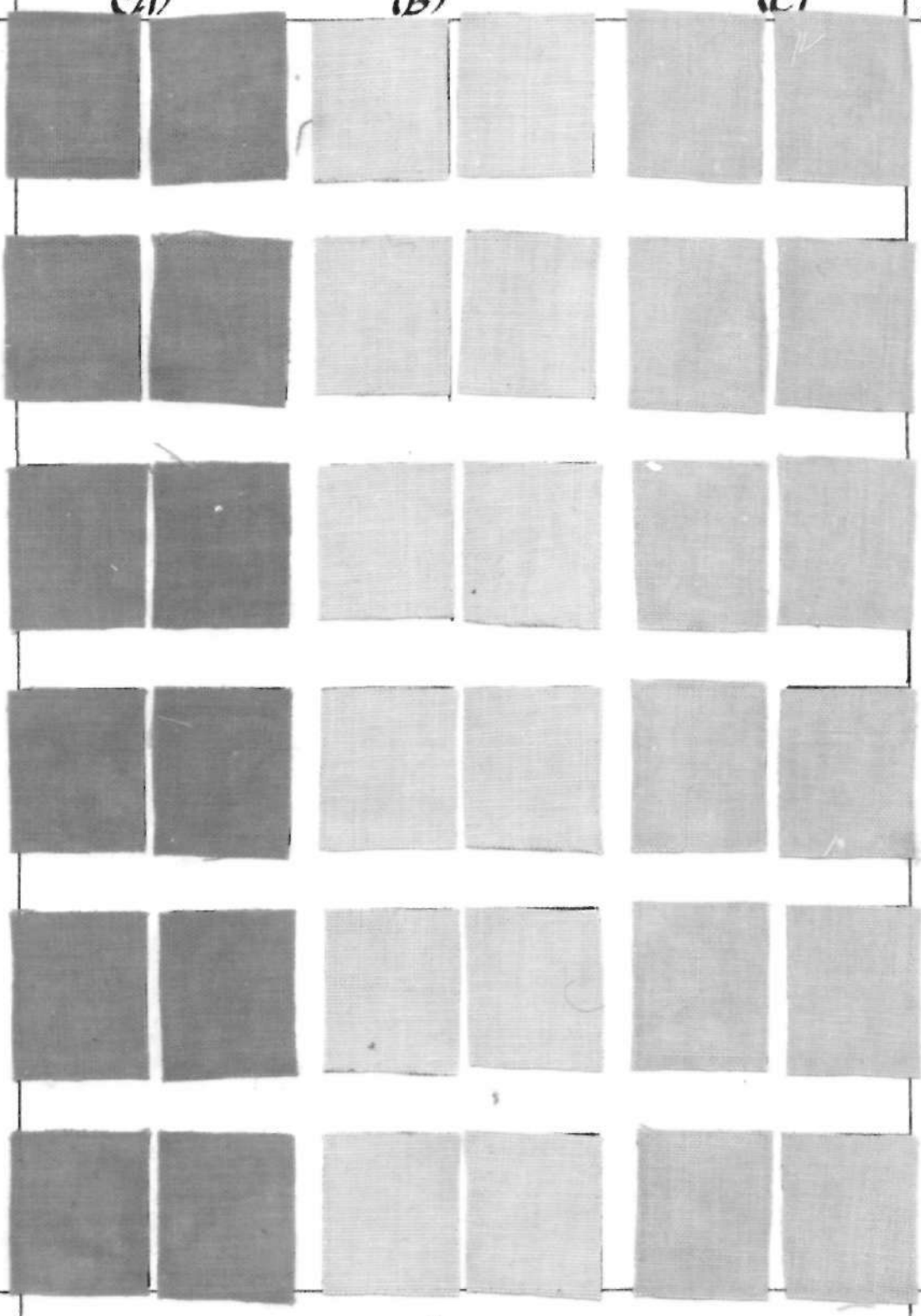
30 minutes hot dyeing

No test

Room and Boiling Temperatures mordanting

86

Copper (A)	Tin (B)	Chrome (C)	121284



'albasa' | | bixa | | 'magina'

Plate IV: No Colour Fastness Test

30 minutes hot dyeing

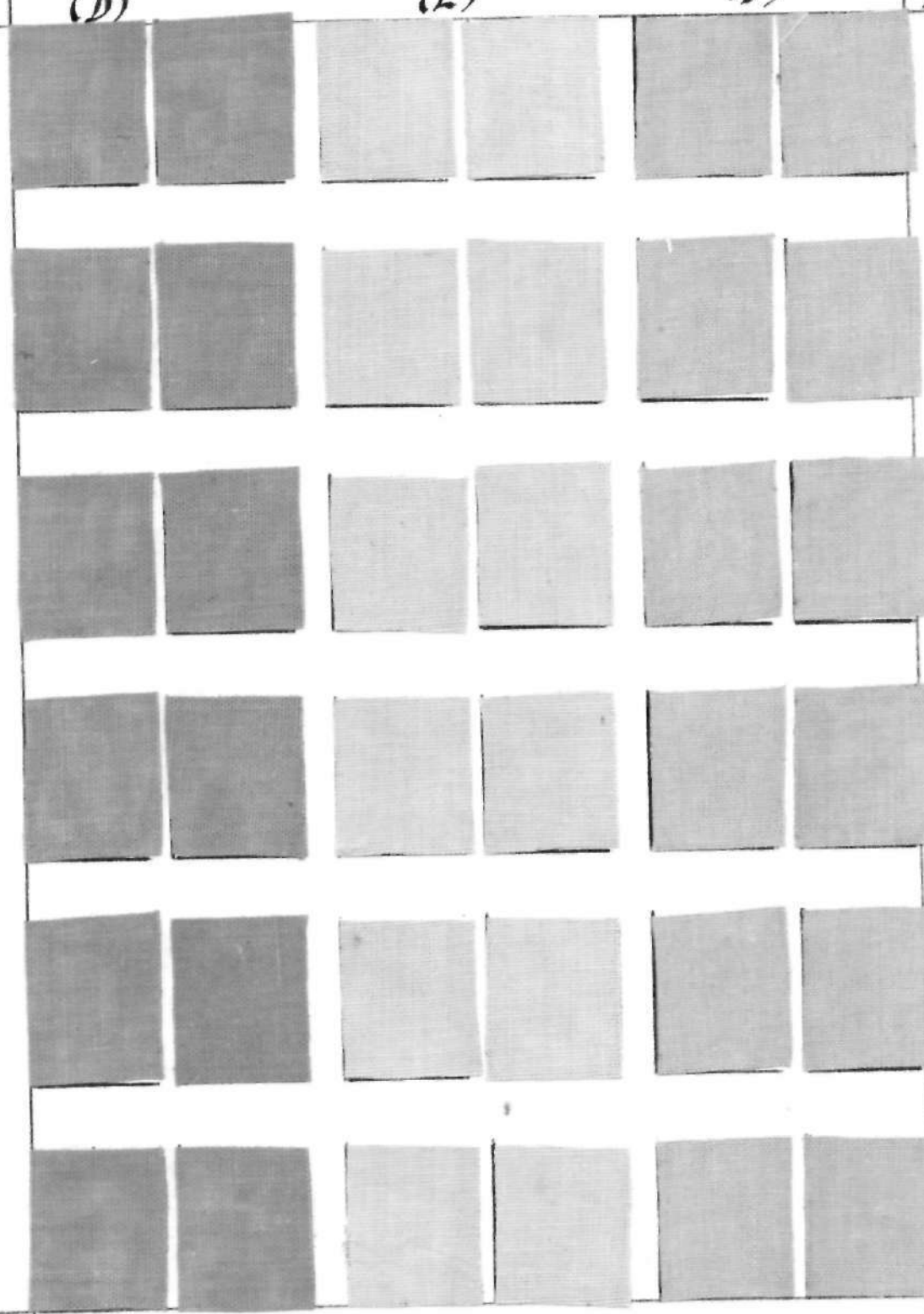
Tested for light fastness

87

Room and Boiling temperatures mordanting

Copper (D)	Tin (E)	Chrome (F)

121284



'albasa' || bixa || 'magina'

Plate V: Light Fastness Test

30 minutes hot dyeing

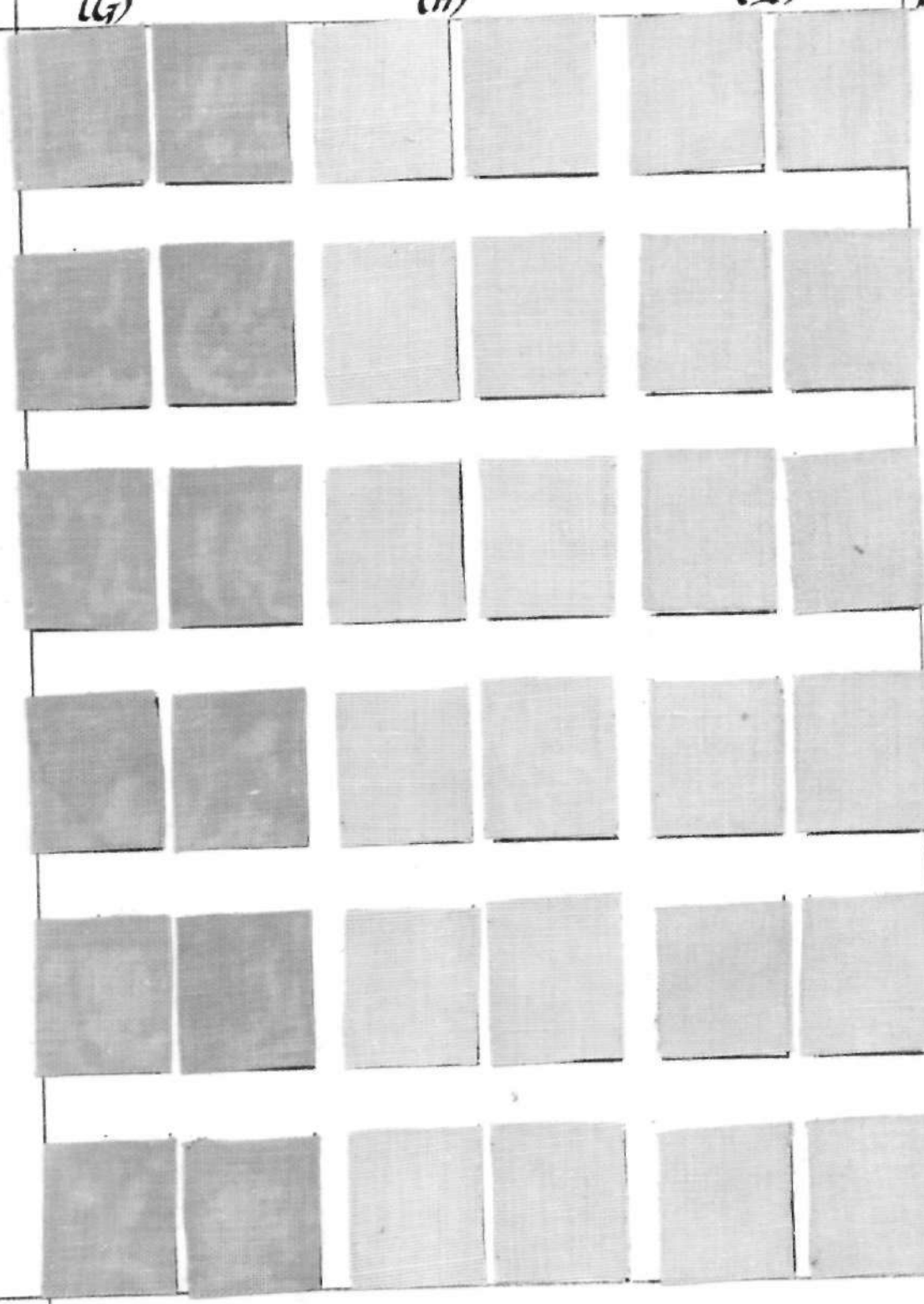
Tested for Wash Fastness

88

Room and Boiling temperatures mordanting

Copper (G)	Tin (H)	Chrome (I)

121284



'albasa' || bixa || 'magina'

Plate VI: Wash Fastness Test

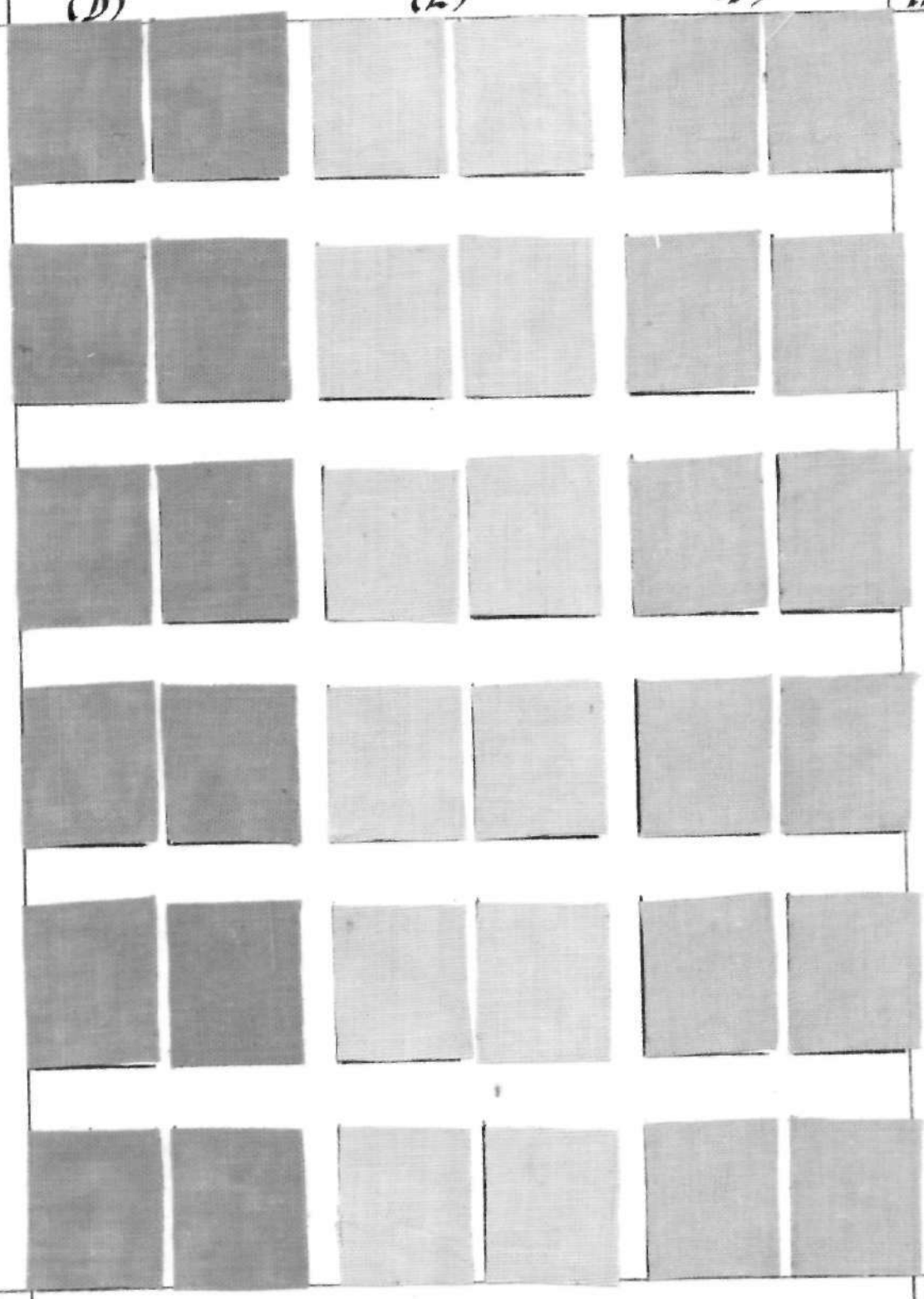
30 minutes hot dyeing

Tested for light fastness

Room and Boiling temperatures mordanting

87

Copper (D)		Tin (E)		Chrome (F)		121284



'albasa' || bixa || 'magina'

Plate V: Light Fastness Test

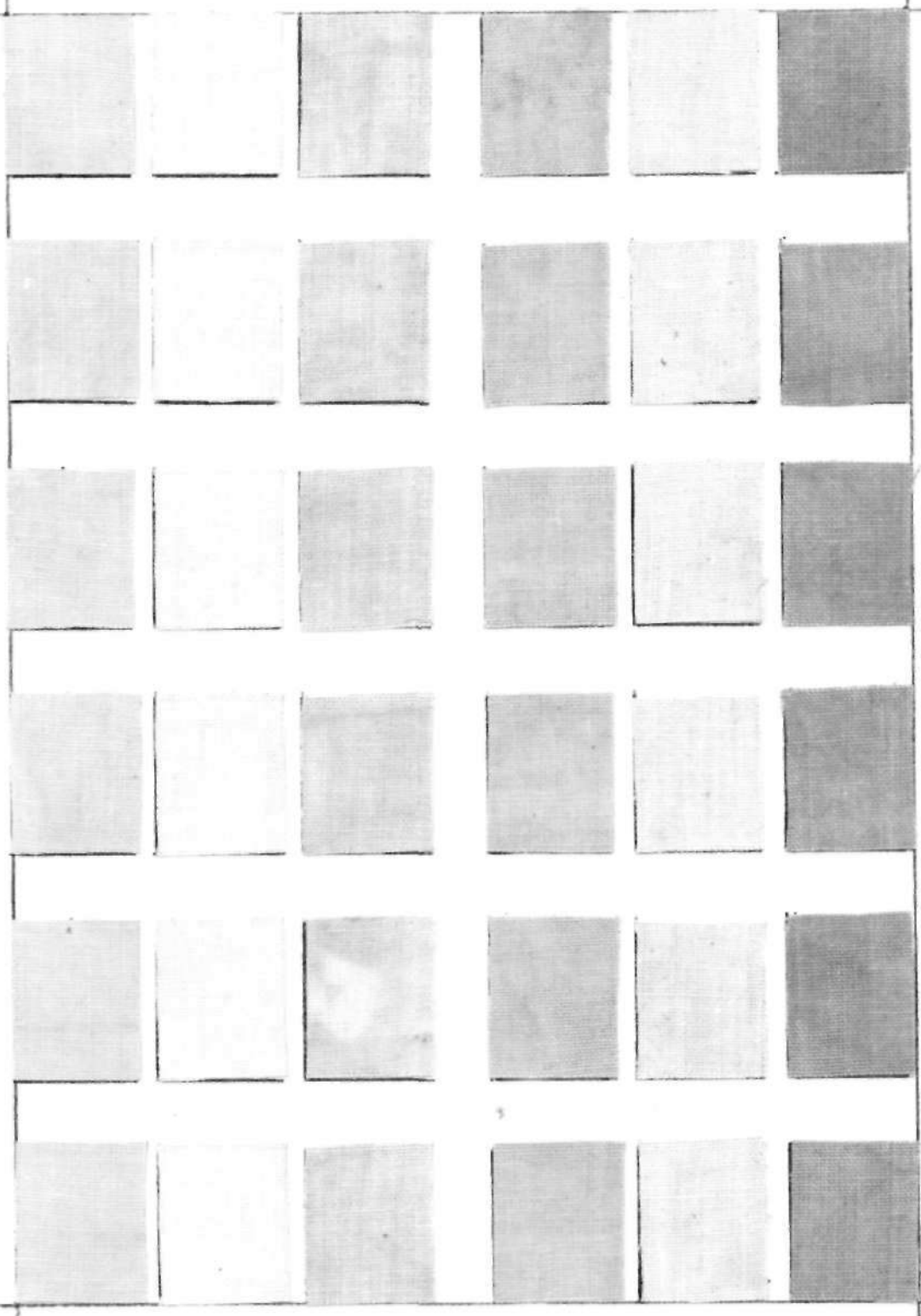
results of the colours produced by the bixa dye plant as can be observed in plates IV , V and VI (i.e. samples 121284 B, E and H).

As earlier stated, water collected from the well was also used in carrying out the dyeing procedures. The difference in shade between tap and water collected from the well was more noticeable when iron mordant was used than copper. This is to say that the difference in shade between the use of water collected from the well and tap water with iron is more pronounced than with copper as contained in sample 12685, plate VIII . The difference in colour between the Samaru-Zaria and Manchok specimens was pronounced with the use of tin and wood ash mordants. Manchok specimens was observed to produce darker shades of colour with the use of tin and wood ash while darker shade was observed on Samaru specimen with the use of iron as shown in sample 101284, plate IX. The best result in terms of colour seemed to be obtained from bixa dye plant when wood ash and tin mordants were used to mordant before dyeing.

Bixa
Room temperature mordanting
30 minutes hot dyeing

Fresh dye material | Dried dye material

30485



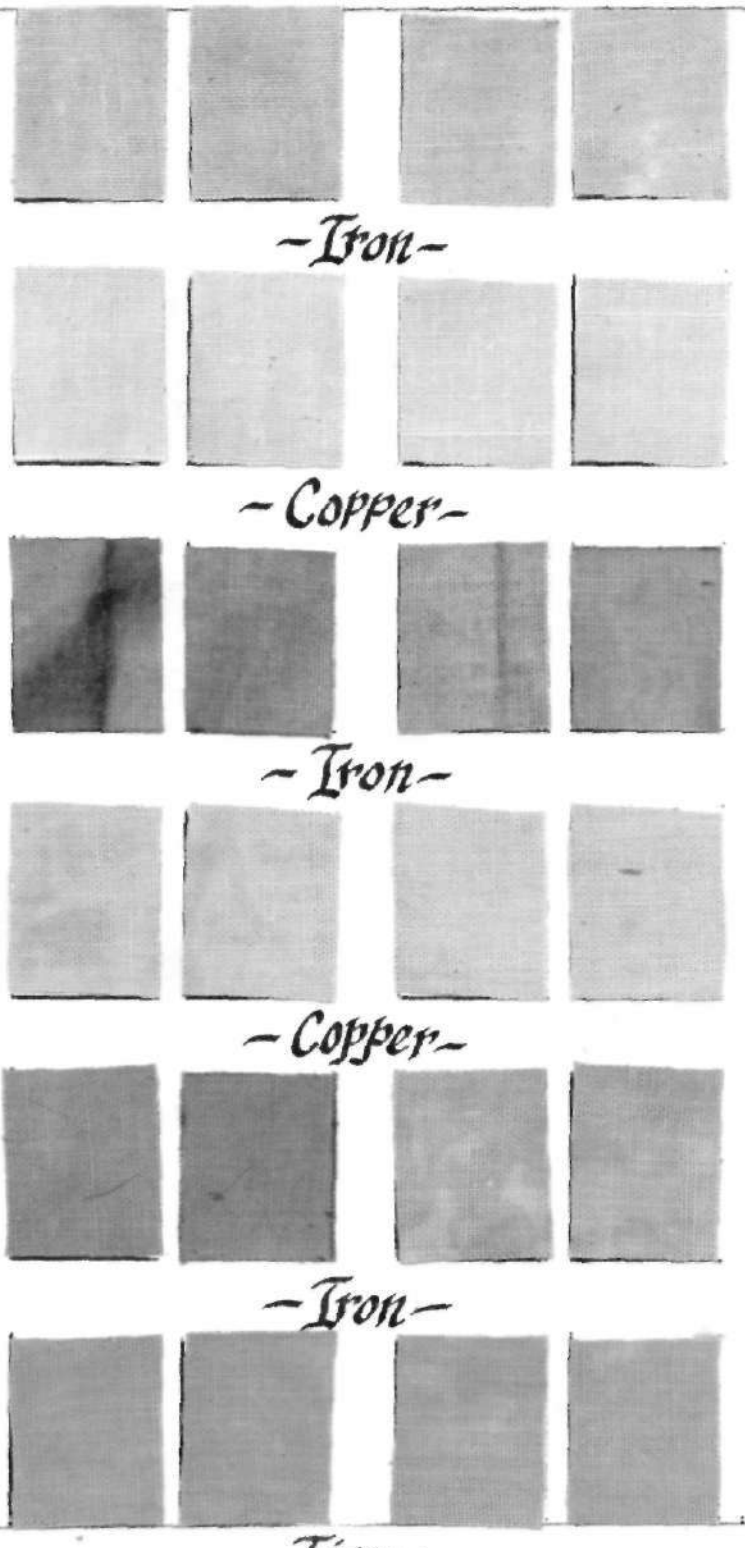
Ash | Chrome | Iron | | Ash | Chrome | Iron

Plate VII: Bixa, Fresh and Dried Specimens

From top to bottom: Bixa, Turmeric & Onion Skins
30 minutes hot dyeing
Room and Boiling temperatures mordanting

91

12685



Well Water Tap Water

Plate VIII: Dyeing with Well and Tap Water.

3.3.4.2 Turmeric ('gangamau'or 'magina')

According to Delziel (1936) Turmeric is indigenous to Soutern Asia where it is said to be cultivated. In West Africa, he stated that turmeric is cultivated along with ginger in the forest aria. It is commonly found in native compaunds grown as a dye plant. He is of the view that the roots are widely used in West Africa to dye leather, thread, palm fibre, etc. Women sometimes smeared it around the eye as cosmetic, Delziel concluded.

The ginger like roots are orange, the surface bri ht orange or carrot colour. The size of the roots depends on the type of soil and weather condition. The fertile and more favourable weather condition, the bigger the size of the roots. It is therefore ea y to grow in a wet tropic which requires a rich soil. In the southern part of Kaduna State, e.g., Kafanchan in Jemaa Local Government Area, turmeric is cultivated for purposes not far from those given by Delzi l above. This dye is not used nowadays in the southern part of Kaduna State as before where the plant was widely cultivated. Th s is because people are no longer interested in such dyes.

The c ltivated plant takes about six months to mature and is ready for reaping when tha leave begin to turn yellow. This dye material used in the study were gathered from Kafanchan, Jema'a Local Government Area and Samaru-Zaria of Kaduna State.

i Collecting and Preserving the Dye Material

Generally, roots obtained for dyeing purposes are best collected when they fully mature. The type used for the study was collected in September and October, 1984 and the roots were preserved, fresh up to January, 1985. In a suitable place when there is no too much dry air, ginger and 'magina' roots can remain fresh for about six months provided they are well covered. The fresh roots were washed in clean water, and the water was allowed to drain before the roofs were smashed.

The roots can preserved fresh or dried. In order to preserve the fresh roots, they were kept and will covered with papers or rag in a cool but not wet area. The specimen was preserved dried by smashing it and was allowed to dry indoors for about one week, depending on the weather condition. It can also be made into powder by pounding the dried material to be sieved into fine powder.

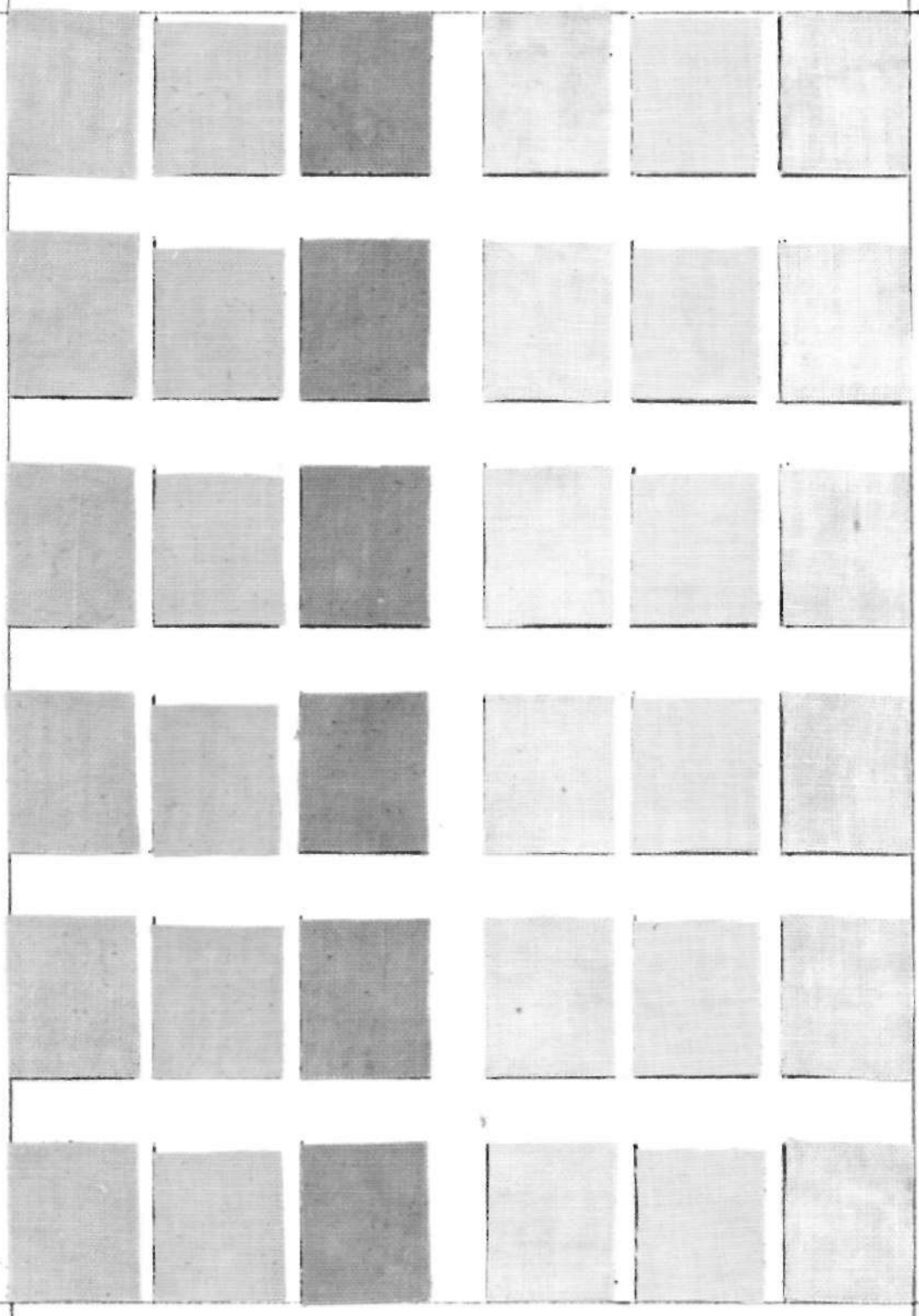
Bixa
Boiling temperature mordanting
30 minutes hot dyeing

94

Samaru-Zaria

Manchok

101284



Ash | Tin | Iron | | Ash | Tin | Iron

Plate IX: Samaru-Zaria and Manchok Specimens

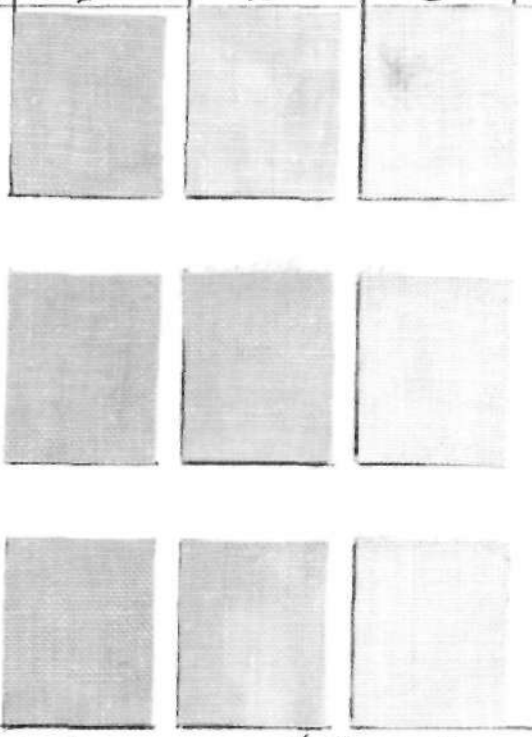
No Mordant

Nos. 1 and 2 – materials boiled before strained out, from top to bottom: 30, 60 & 90 mins. hot & cold dyeing

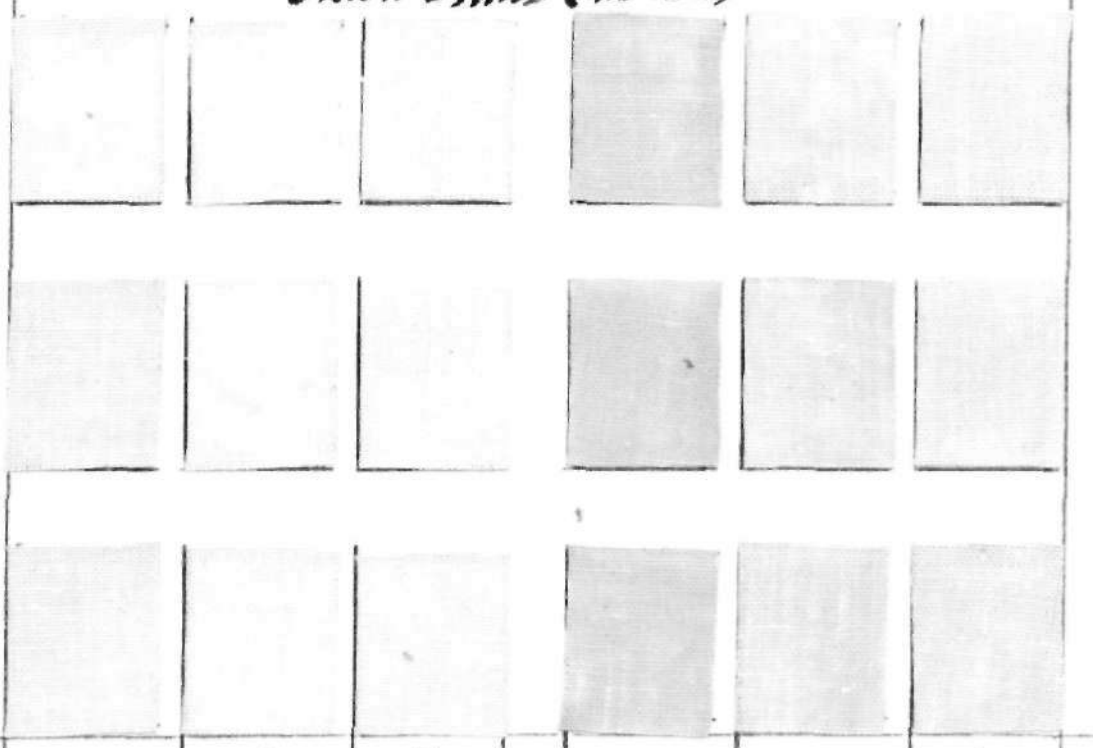
No. 3 – Materials strained before boiled, 30-90 mins. hot dyeing

	1	2	3

6685



Onion Skins (albasa)



1	2	3	1	2	3
Bixa			Tumeric (magina)		

Plate X: Cold and Hot Methods of Dyeing

Preserved dye materials should carry labels indicating where and when the material was gathered.

ii. <u>The Dyebath and Actual Dyeing Procedure</u>

The fresh dye specimen was soaked (after smashing) for six hours while the dried specimen was soaked for twelve hours. The temperature of the soaked specimen was raised to boiling point and was held at that temperature for 30 minutes. The dye bath was allowed to rest and the specimen or material later strained out. Unmordanted samples were dyed from five to 120 minutes to determine the effect of time in vegetable dyeing as contained in sample 7635 (c), Plate III. In the case of sample 6685, Plate X, hot and cold methods of dyeing were carried out. Addition of water in cold method of dyeing was not necessary since little amount of water evaporated. The dyebath was allowed to cool after boiling for 30 minutes, dye material was strained out before the actual dyeing.

iii. Amount of Dye Possible for Extraction

20 grams dye specimen to 150 ml. of water were weighed. The fresh specimen was soaked in this quantity of water for six hours and boiled for 30 minutes. The material or specimen was allowed to cool down and was later strained out. What was got was a highly concentrated dye solution and this was left in a glass tray for about one week depending on weather condition. After evaporation, some powder which weighed about 2.7 grams was left. The powder was the amount of dye possible for extraction. Therefore, 20 grams of the fresh material appeared to be capable of producing about 2.7 grams of dye. This amount of dye could dye a 10 grams of fabric, which is approximately two metres of fabric. Over half a tonne of the fresh specimen is estimated. to be capable of being collected yearly in the area of the study.

iv. Colour Fastness

Colour obtained from 'magina' dye plant was not fast especially to washing without the help of mordant as observed in samples 7585 (c) and 5685 (c), Plates II and III. When the samples were mordanted with chrome before dyeing and

tested for light and wash fastness, the colour was fast to both light and washing as contained in samples 121284 (C), (F) and (I) as already shown in plates IV, V and VI.

v. Results

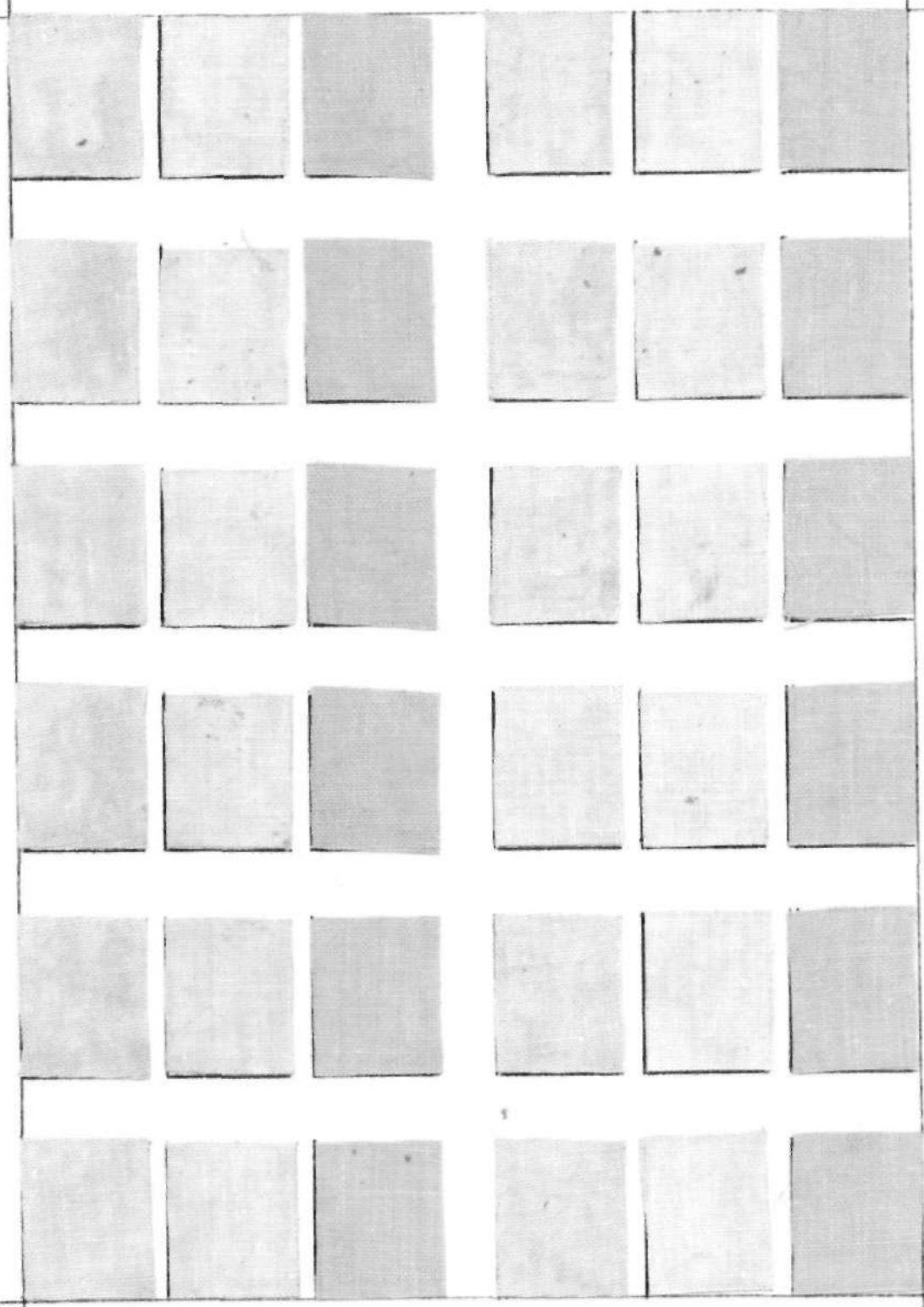
Turmeric dye plant produced a clear yellow without a mordant as contained in sample 7685 (C), Plate II. When mordants were used, the plant changed from yellow to yellow ochre and orange colours. Tin yielded orange colour which is similar to that of the fresh dye material (sample 7685 (E), Plate II).

Water collected from the well was also used in the dyeing procedure, and some mordants were observed to react with the mineral (impurities) contents of this water to give a different shade of colour from those produced when tap water was used. Iron, for example, reacted more strongly with the mineral contents in well water more than copper as shown in sample 12685, already shown in Plate VIII.

Turmeric (gangamau, magina)
Boiling temperature mordanting
30 minutes hot dyeing

Samaru-Zaria Kafanchan

17385



No Mordant | Alum | Copper | No Mordant | Alum | Copper

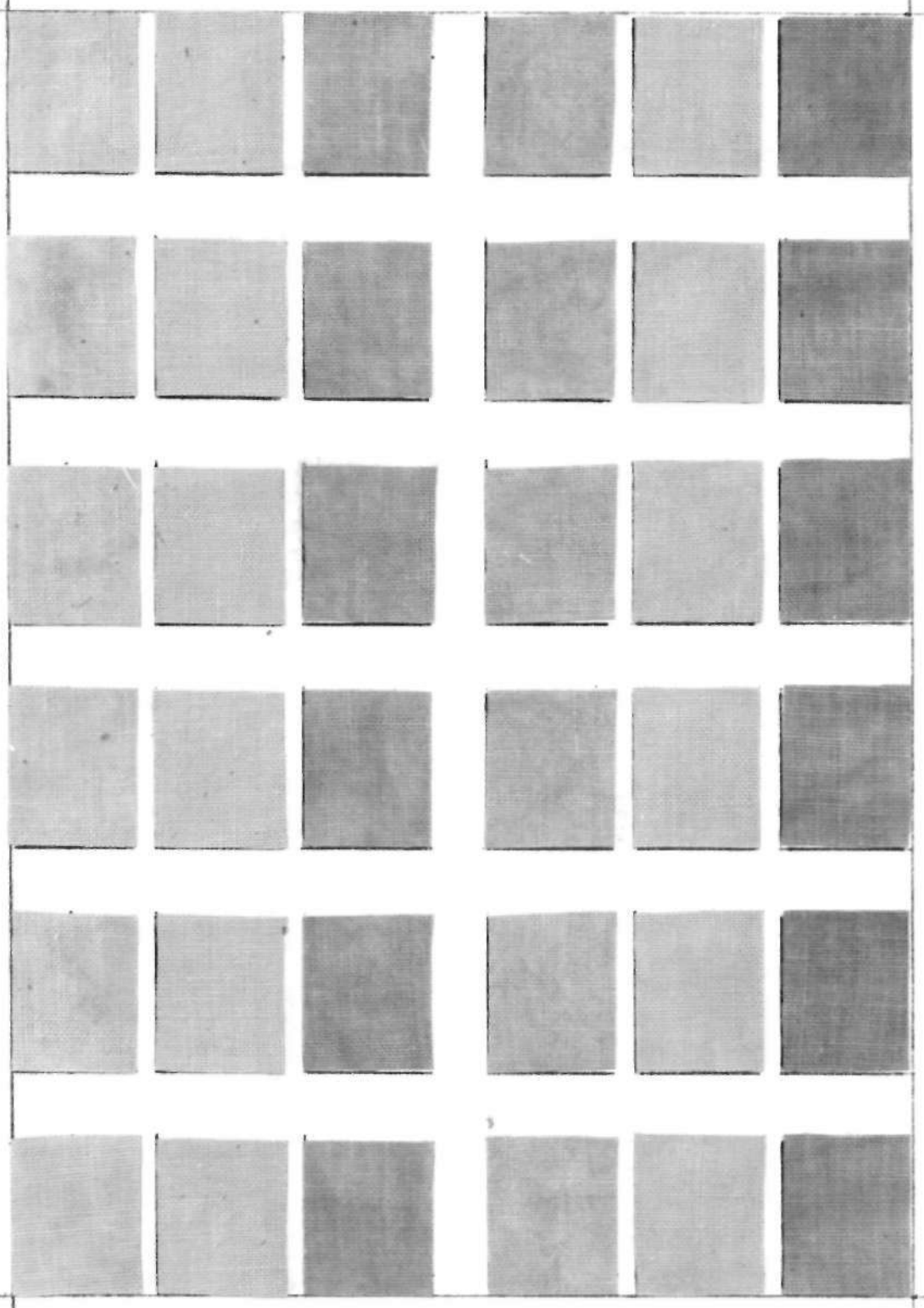
Plate XI: 'Magina', Samaru-Zaria and Kafanchan Specimens

Turmeric (Dangaman, Magina)
Room temperature mordanting
30 minutes hot dyeing

100

Fresh dye material | Dried dye material

14185



Ash | Copper | Iron | | Ash | Copper | Iron

Plate XII: 'Magina', Fresh and Dried Specimens

As earlier stated in this chapter, Turmeric roots for the study were gathered from Kafanchan and Samaru, Zaria. Colour got from this species from these two different geographical environment, showed no significant difference in shade without the use of mordant. When copper and alum were used as mordants, the different was not very much observed, as shown in Plate XI.

The difference in shade was more noticeable between the fresh and dried specimen of the same area especially with iron mordant as contained in sample 14185, Plate XII. In the presence of a mordant, no significant difference in shade was observed between boiling and room temperatures and time seemed to have no significant effect both on mordanting and dyeing processes. There also seemed to be no significant difference in the shade of colour between 30, 60, 90 and 120 minutes hot dyeing as already observed in sample 7685 (c), Plate III.

3.3.4.3 ONION SKINS ('albasa')

The outer skins were used for the dyeing purpose. Onion skins or 'albasa' are not hard to come by, especially in the northern part of Nigeria, where it is more widely cultivated than in the southern part of the country.

i. Collecting and Preserving the Dye Material

Onion skins are best collected in the dry season. During this period, onion is mostly available in the market. This is not to say onion skins cannot be collected in the raining season.

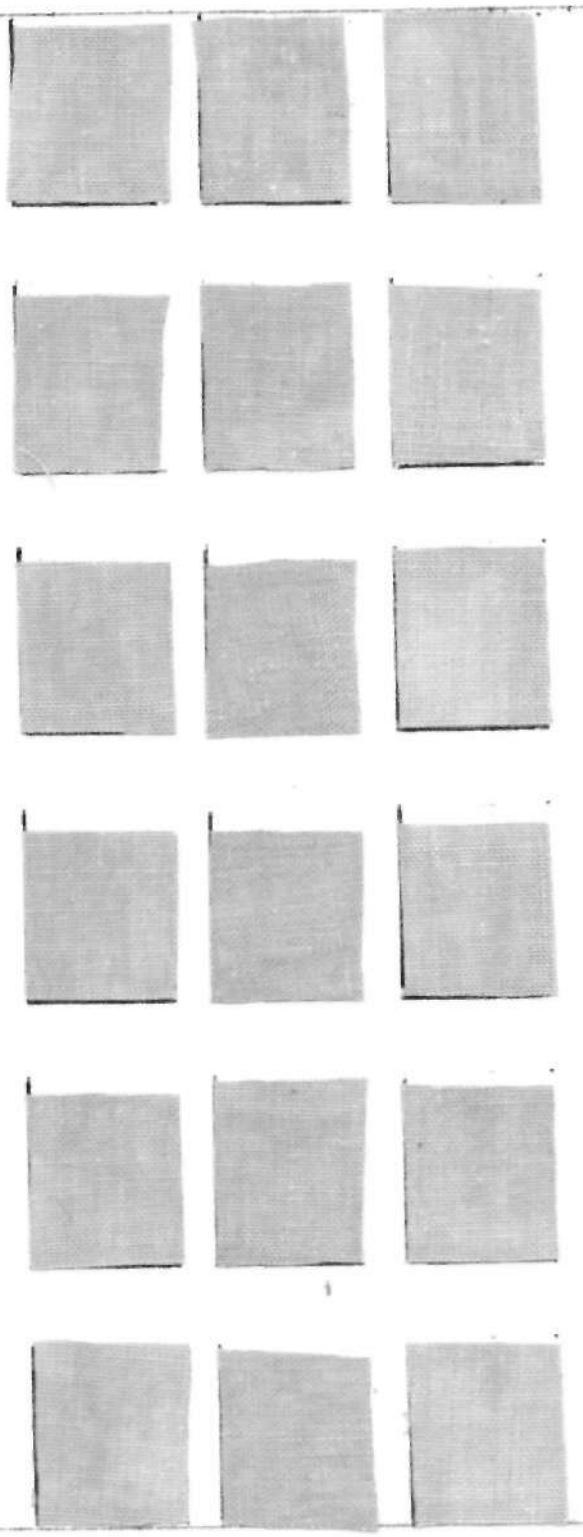
When they are collected (normally dried), they can be preserved by further spreading them indoors. Some foreign bodies like Stones, decayed onion, papers, etc., were seperated from the skins. They can then be put in paper bags to be kept in a dry place with a label indicating the place where the specimen or material was grown and also the time in which the material was gathered.

For the purpose of the study, the skins of onion farmed or grown in Kura, Kano State,

Onion Skins (albasa)
No mordant
From top to bottom: 5, 10, 30, 60, 90
and 120 minutes hot dyeing

103

13385



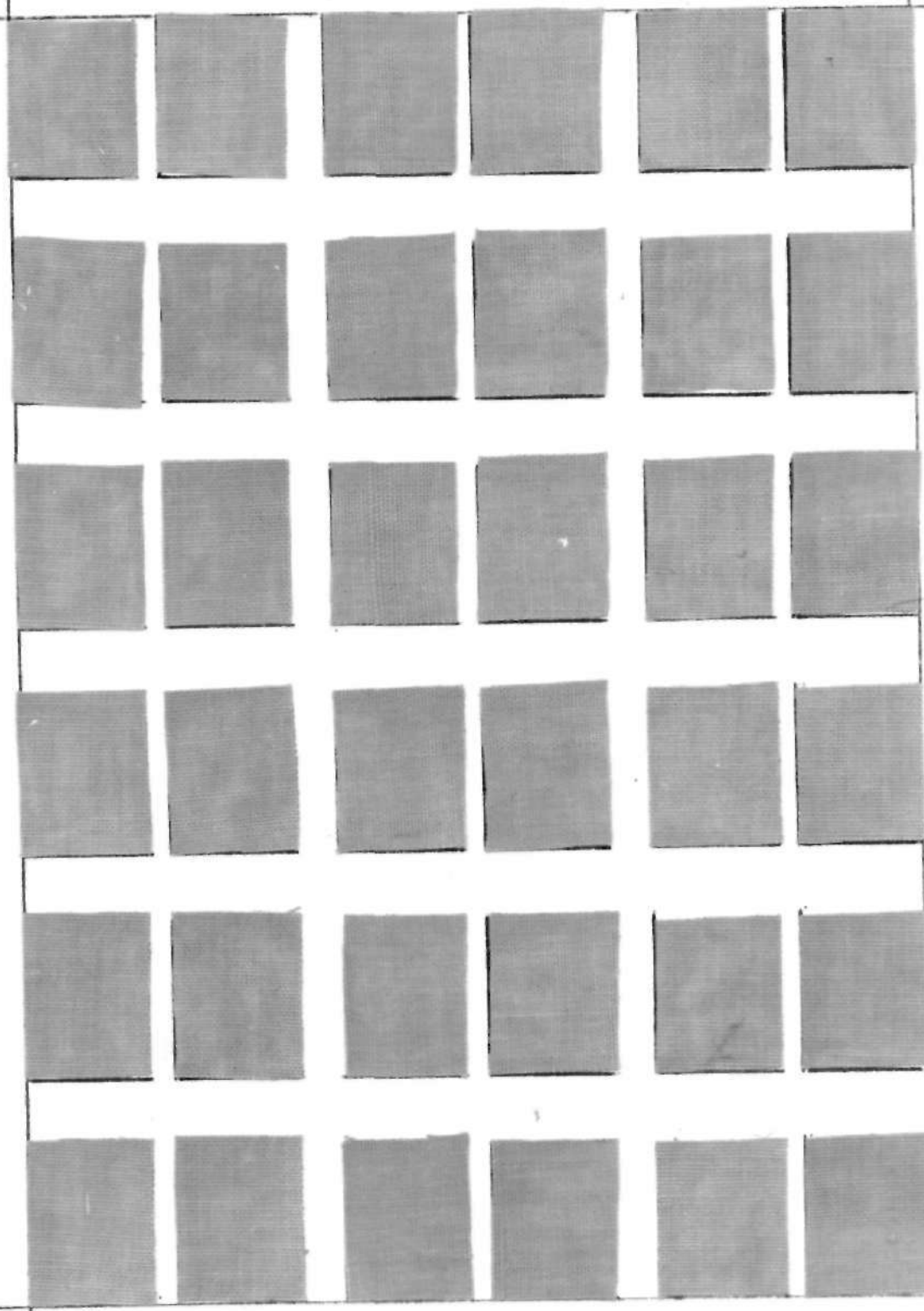
Kura | | Miana | | Zaria

Plate XIII: No Mordant. Kura, Miana & Zaria Specimens

Onion Skins (albasa)
Tin (Stannous chloride)
Room and Boiling temperatures mordanting
30 minutes hot dyeing

104

26185



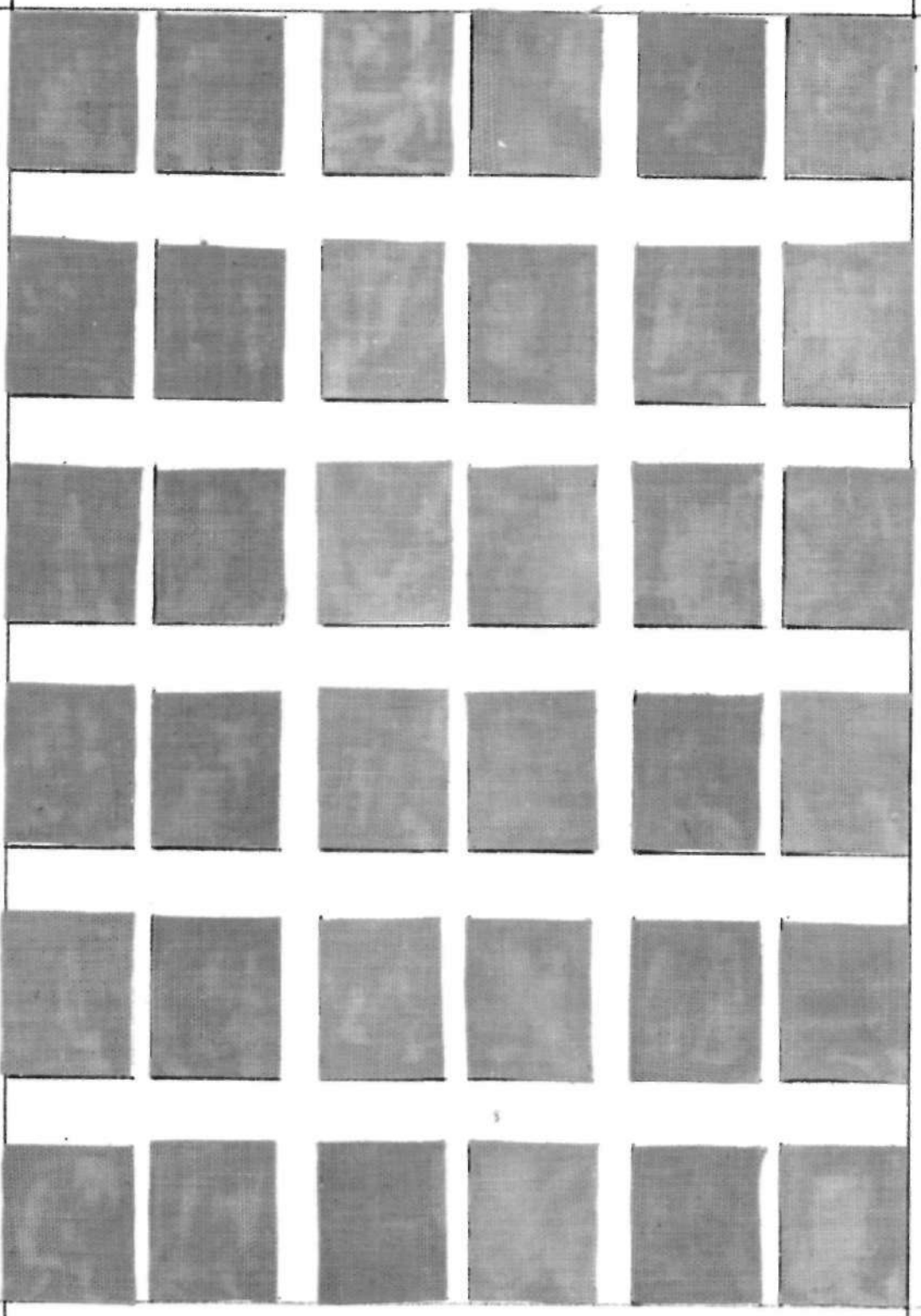
Kura || Minna || Zaria

Plate XIV: Tin Mordant. Kura, Minna & Zaria Specimens

Onion Skins (albasa)
Iron (Ferrous Sulphate)
Room and Boiling Temperatures mordanting
30 minutes hot dyeing

105

27185



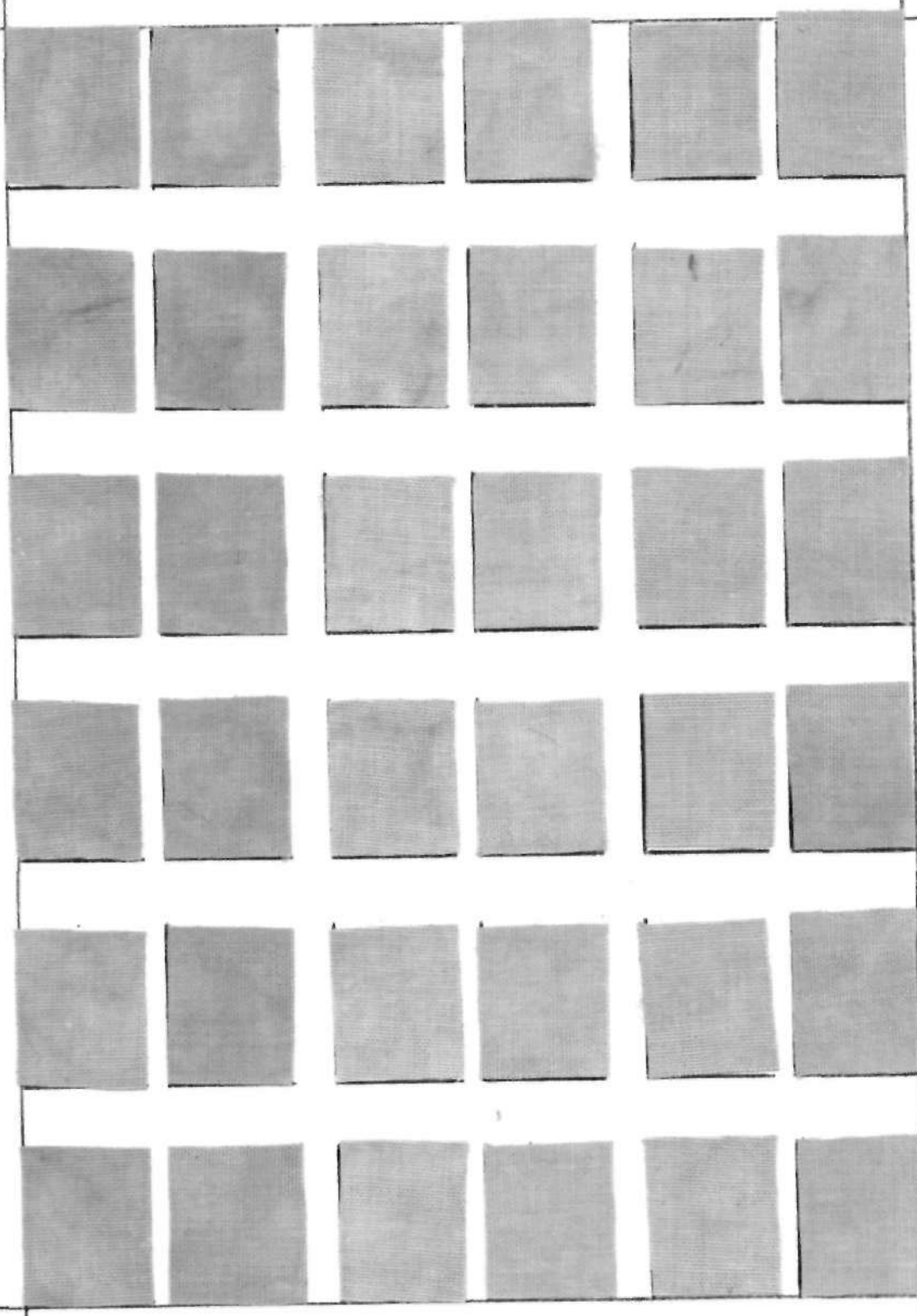
Kura || Minna || Zaria

Plate XV: Iron Mordant. Kura, Minna & Zaria Specimens

Onion Skins (albasa)
Wood Ash
Room and Boiling temperatures mordanting
30 minutes hot dyeing

106

28185



Kura | | Minna | | Zaria

Plate XVI: Wood Ash. Kura, Minna & Zaria Specimens

Minna, Niger State and Zaria, Kaduna State were tried as contained in samples 1385, 26185, 27185 and 28185, Plates XIII to XVI .

The choice of these areas was found necessary because of their difference in geographical location. Kura in Kano State is nearer to the extreme end of the country, Minna, Niger State is also near the southern part of Nigeria more than Kura, while Zaria, Kaduna State is in-between Minna and Kura.

ii. <u>The Dyebath and Actual Dyeing Procedure</u>

This dye material is unlike the 'magina' and bixa dye plants. Only the dried dye material is necessary for the dyeing procedure. In order to prepare the dyebath, 10 grams of the onion skins was covered with 300 ml. of water as already stated earlier in this chapter. This was soaked for six hours and later boiled for 30 minutes. The material was strained out before the samples were entered and dyed for 30 minutes. In the case of samples contained in Plate XIII, the samples were dyed at boiling point temperature for five to 120 minutes intervals. The dyebath was allowed to rest

before final rinsing in cold clean water. This was later dried.

iii. Amount of Dye Possible for Extraction

20 grams of the dye specimen was weighed and covered with 200 ml. of water. This was soaked for six hours. The dye specimen was boiled for 30 minutes and allowed to cool before straining out the onion skins. It was difficult to obtain powder deposit from onion skins dye solution. Therefore, the amount of dye possible for extraction, can better be got through the weight to volume method, that is, 20 grams of onion skins to 200 ml. of water. After the usual six hours soaking, 30 minutes boiling and straining out the skins, 150 ml. of the dye solution was obtained. 150 ml. of water was added to this dye solution to make it up to 300 ml. of dye solution. This amount of dye solution could dye a 7 grams (approximately one metre) of fabric. For the purpose of this study, about two kilograms of onion skins can be retained for a year use. More onion skins are required to dye in large quantity.

iv. Colour Fastness

The colour obtained from 'albasa' was not fast especially to washing without the help of a mordant as contained in samples 5685 (A) and 7685 (A), Plates II and III. When copper was used to mordant before dyeing and tested for light and wash fastness, colour was observed to be fast both to light and washing as observed in samples 121284 (A, D and G), already shown in plates IV, V and VI. The effects of temperature and time on the mordanting process played insignificant role on the final results of the colour obtained from 'albasa'.

v. Results

Generally without mordant, onion skins used in the study produced light brownish colour. With the help of various mordants, shades of this colour varied from brown to olive brown colours. Tin mordant for instance, altered the shade of the original (colour produced without mordant) colour to olive and orange brown colours. Copper resulted to greenish colour while alum and wood ash produced almost tho same shade of colour which was brownish colour. This was all

under the same dyeing conditions and the same dye plant as already shown in plate II.

Specimens gathered from Kura, Kano State produced a deeper green than that from Zaria while Minna onion skins produced lighter green, all with iron mordant under the same dyeing condition. Colours obtained from the specimens collected from the three different geographical locations of the study, showed little difference in shade with the use of wood ash, as shown in plates XIII to XVI.

Well and tap water was used in carrying out the dyeing procedure though the greater number of the tests was done with tap water. The difference in shade of colour with the use of tap and water collected from the well was more observed when iron was used than tin as already shown in Plate VIII.

3.4 SUMMARY

This chapter describes the population used to provide the data for the study. The experimental procedures and results which include the general information on the mordanting, dyeing and colour

fastness tests procedures are discussed. Also discussed, are the individual plants which describes the method of collecting and preserving the individual dye specimen. The preparation of the individual dye bath and actual dyeing procedures as well as the amount of dye possible for extraction, colour fastness test and results for each dye producing plant of the study are also discussed. Chapter four presents the details of the analysis.

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CHAPTER - IV

PRESENTATION AND ANALYSIS OF DATA

4.1 Introduction

4.2 Summary of Data Findings

4.1 INTRODUCTION

The set objective of the study as earlier stated, was to determine the amount of dye that can be extracted from plants and to examine the fastness properties of such dyes to cotton febric. The results of the tests on the samples in the study formed the basis for the analysis. This chapter therefore, contains the presentation, analysis and discussions of the data for the study based on the research questions.

Research Question One

Research question one asks of ways appropriate for extracting dyes from plants. The analysis for this research question are presented by the samples in plate x in chapter III.

For each dye plant used in the study, three different baths were prepared as follows:

i. Each dye specimen or material was weighed and covered with water (10 grams dye plant to 300 ml. of water) and soaked for a length of time depending on the type of the dye material. After soaking, the plants were each boiled for 30 minutes, allowed to rest and the material was later strained out. Unmordanted samples were entered and temperature of the dyebath was gently raised to boiling point and time was taken. After 30 minutes when the samples were in the dyebath, a sample was taken out, squeezed and rinsed in clean cold water. Other samples were removed from the dyebath after . 60, 90 and 120 minutes intervals.

ii. Each dye plant was weighed and covered with water, soaked and boiled and dye-plant strained out as mentioned above. After straining the dye material, dyeing commenced as in the above method except that dyeing was carried out at room temperature.

iii. Each dye plant was weighed, covered with water and soaked, the dye-plant was strained out leaving pale shades of dye solutions. Unmordanted samples were also entered and dyed at boiling temperature. From the final results got from these methods, it was apparent that the most appropriate way by which dyes can be extracted from plants was by raising the temperature of the dyebath for 30 minutes (i.e. boiling the dye material for 30 minutes). It was also apparent that the most appropriate methods of dyeing with vegetable dyes was to raise the temperature of the dyebath for 30 minutes.

Research Question Two

What amount of dye possible for extraction from some species of plants? This question is asked in research question two of the study.

In order to answer the question, 20 grams of fresh 'magina' and bixa dye plants were each soaked for six and three hours respectively in 150ml. of water. The plants were each boiled for 30 minutes and allowed to rest. The plants

were then strained out leaving a highly concentrated dye solutions. The solution for each dye plant ('magina' and bixa) was left in a glass tray for one week resulting in powder deposit. The powder obtained from 'magina' dye plant weighed about 2.7 grams while that obtained from bixa dye plant weighed about 1.5 grams. It can be inferred that the amount of dye possible to be extracted from 20 grams of 'magina' and bixa dye plants can be 2.7 grams and 1.5 grams respectively.

20 grams of onion skins, 'albasa', was also got and covered with 200 ml. of water. This was soaked for six hours which was later boiled for 30 minutes and allowed to cool down. The onion skins was strained out. As earlier discussed in Chapter III, it was difficult to obtain powder from onion skins concentrated dye solution. Therefore, the amount of dye possible for extraction, can better be got through the weight to volume method. It can be inferred that amount of dye possible to be extracted from the 20 grams of the onion skins can be about 150 ml. of the dye solution.

Research Question Three

To what degree will some dyes be fast to cotton fabric?

In order to answer this research question, samples 7685 (A to C), Plate-II, Chapter-III, were dyed at boiling temperature for a period of five to 120 minutes as discussed in research question one. The samples or specimens were rinsed in clean cold water and dried. They have not undergone colour fastness test. Specimens contained in Plate-III were also as those in Plate-II, but have undergone light and wash fastness tests. When the specimens on the two Plates (Plates II and III) were compared, it was apparent that colours obtained from the three different dye plants of the study, were not fast to light and washing.

Specimens were mordanted before dyeing and tested for light and wash fastness. These were compared with the same specimens which have not undergone light and wash fastness tests. From the observation, it appeared that the colours obtained from bixa, 'magina' and 'albasa' dye

plants were fast to both light and washing as contained in plates IV, V and VI.

Research Question Four

What type and amount of colour could a dye plant yield in a certain geographical environment?

The analysis for this question is presented in Plates IX, XI, XII, XIII, XIV, XV and XVI in Chapter III. Plate IX (sample 101284) showed wood ash, tin and iron mordanted dyed specimens. Dye plant for these specimens or samples were from the same species, bixa, collected from two different geographical locations - Manchok and Samaru-Zaria. The same dyeing ingredients were employed. It was observed that Manchok specimens produced darker shades of colour with the use of tin and wood ash while daker shade was observed on Samaru-Zaria specimen with the use of iron.

Plate XI (sample 17385) contain alum, copper and unmordanted dyed specimens. The same dye plant, 'magina', collected from Kafanchan and Samaru-Zaria. Under the same dyeing condition, the difference in shade appeared to be insignificant.

Plates XIII, XIV, XV and XVI also contain tin, iron, wood ash and unmordanted dyed specimens. The dye plant, 'albasa', was collected from Kura, Minna and Zaria. Specimens dyed without mordant, Plate XIII, the difference in shade of colour was insignificant under the same dyeing condition. Plates XV and XVI contain wood ash and iron mordanted dyed specimens. Kura onion skins contain a more brownish colour than Minna and Zaria onion skins, while with iron, Minna onion skins appear to produce a lighter green colour.

Plate XIV (sample 26185), olive brown colour was obtained from Kura onion skins, orange brown from Minna dye plant while 'albasa' gathered in Zaria produce between olive and orange brown colour with tin mordanted specimens or samples and under the same dyeing condition.

From the results of the tests performed in the study, it appears that the geographical location in which the dye plant is gathered can alter the colour shade of the same species of plant gathered from different geographical locations. This is especially true with the

help of mordants and this also depends on the individual mordants and dye plants.

Research Question Five

What contribution would certain mordants make to extraction of dyes from plants?

Specimens contain in Plate II, Chapter III, showed the six different mordants used in the study as earlier discussed. Under the same dyeing condition, bixa dye plant produce light pink colour without the help of mordant. When various mordants were used to mordant the samples before dyeing, the shades of colours vary from pink to dark pink and brown. The roots of 'magina' dye plant yield clear yellow without the help of mordant. This dye plant produce from yellow to yellow ochre when the specimens were mordanted with various mordants. Onion skins, 'albasa', used in the study produce light brown colour without mordant. When various mordants were introduced to the fabric, the colour shades vary from brown to olive green. As already analyzed in research question three, colours obtained from the dye plants in the study were not fast to light and washing without

the help of mordant. It can be said here that mordant does not only help in altering the shade of colour of the same dye plant but also help the colour to be fast to light and washing.

Research Question Six

Will the type of water used in carrying out vegetable dyeing have any effect on the shade of such colour?

The analysis for this research question is presented in plate VIII, Chapter III. Iron and copper were used to mordant the specimens before they were dyed with bixa dye plant. From the plate, it was observed that the difference in shade of colour was more noticeable between well and tap water when iron mordant was used to mordant than copper. When iron and copper were also used to mordant and dyed with 'magina' dye plant, it was again observed that difference in shade of colour was more noticeable when iron mordant was used than copper. It was also observed from the same Plate (VIII) that this difference in shade between the use of water collected from the well and tap water was more pronounced when iron mordant was used than when

tin was used with dye obtained from 'albasa'. From specimens contained in plate VIII, therefore, it was apparent that though the type of water used in carrying out vegetable dyeing may slightly alter the shade of colour of the same dye plant, this will depend very much on the individual mordant used and the type of dye plant. Iron mordant can be said to react more with the mineral contents in well water than tin and copper.

4.2 SUMMARY OF DATA FINDINGS

All results of the tests on the specimens or samples performed in the study have been examined and analysed in this chapter. The six research questions were tested or answered by either raising the temperature of the dyebath and mordant bath to boiling point or the temperature was held at room temperature.

It was found in the study that the most appropriate way by which dye can be extracted from plants was by boiling the dye material for 30 minutes. It was also found from the tests performed in the study, that the most appropriate

way for vegetable dyeing was to raise the temperature to boiling point for 30 minutes. The specimens used to answer the research question are presented in plate X, Chapter III.

From the results of the tests performed in the study it can be inferred that the amount of dye possible for extraction from 20 grams of bixa and 'magina' dye plants are 1.5 grams and 2.7 grams respectively. 20 grams of 'albasa' is also capable of producing 150 mls of dye solution. This answered research question two of this study.

Mordants helped in making colour stay permanently on the cotton fabric, hence the colour was fast to light and washing. The introduction of mordant to the fabric also helped in varying the shades of colour of the same dye plant as specimens contained in plates II, III, IV, V and VI of research questions three and five.

The same species of plant gathered from different geographical environment often have some change in shade and this depends on the mordant plant combination as specimens presented in plates IX, XI, XII, XIII, XIV, XV and XVI, research question four.

Specimens used to answer research question six are presented in plate VIII. It was observed from plate VIII that the use of tap water and water collected from the well in carrying out vegetable dyeing may alter the shade of colour of the same dye plant but depends on the individual mordant plant combination.

Chapter V contains the summary and discussion of findings, conclusions and recommendations.

CHAPTER - V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

5.2 Summary of Data Findings

5.3 Findings in Relation to Previous Research

5.4 Conclusions

5.5 Implications of the Findings to Textile Education

5.6 Recommendations for Future Research.

5.1 INTRODUCTION

This chapter contains a summary of the study that includes the purposes, problems, procedures and methodology of the study, followed by a summary of the data findings as they relate to the data collecting instrument and previous research conclusions are drawn based on the findings and recommendations for future research in line with the findings.

The main objective of the study was to determine the amount of dye extracted from plants and to also examine the fastness properties of such dyes on cotton fabric. The concern of the study therefore, was with the extent to which dyes can be extracted

from plants as well as examining the fastness properties of such dyes on cotton fabric.

The population of the study was three dye producing plants namely: bixa, turmeric ('gangamau' or 'magina') and onion skins ('albasa'). Area of coverage include Kaduna, Kano, and Niger States of Nigeria. Cotton fabric, tap water and water collected from the well and six different mordants were also included in the population of this study.

Experimental procedure was designed in which the following processes of data collection were employed;

1. Ways by which dyes can be extracted from species of plants in the population.
2. Extracts from at least two different geographical environments of the same species of the dye plant.
3. Six different mordants (wood ash, alum, chrome, copper, tin and iron) were used on each dye producing plant.

4. Tap water and water collected from the well were used in the dyeing procedure (though the greater part of the experiments were done with tap water).

5. Certain quantity of dye was obtained from each dye producing plant.

6. Tests for colour fastness to light and washing were carried out in this study.

To achieve the above objectives, the study was further divided into the following areas of operations:

1. Mordanting process

2. Dyeing Process

3. Colour fastness tests

4. Each dye plant, the method of collection and preservation, preparation of dyebath, amount of dye possible for extraction, colour fastness tests and results were carried out.

5.2 SUMMARY OF DATA FINDINGS

Based on the analysis of the data contained in chapter IV of the study, the following data findings are pertinent:

1. The most appropriate way by which dyes can be extracted from plants, is by boiling the dye material for 30 minutes after 2 to 12 hours of soaking. It also appears that the most appropriate method of vegetable dyeing is by raising the temperature of the dyebath to boiling point and held for 30 minutes.

2. 20 grams of bixa and 'magina' dye plants produced about 1.5 grams and 2.7 grams of dye respectively while 20 grams of 'albasa' produced 150 ml. of dye solution.

3. Colours obtained from bixa, 'magina' and 'albasa' dye plants were only fast to light and washing on cotton fabric when the cotton fabric was mordanted 30 minutes in hot dyeing.

4. Though dye plants vary (in terms of shades of colour) from one geographical location to another, colour of shades depend very much on individual plant and mordant used.

5. Data findings indicate that because of their ability to alter the dye colour, various mordants produce different final results from the same dye plant.

6. Based on the data finding contained in chapter IV, the type of water used in carrying out vegetable dyeing appear to slightly alter the shade of colour of the same dye plant depending only on the individual plant and mordant used.

5.3 FINDINGS IN RELATION TO PREVIOUS RESEARCH

From the review of the related literature, summary of data findings and conclusions, the following inferences are notable.

It was found in the study that the most appropriate way by which dyes can be extracted from plants is by boiling the dye material for 30 minutes after a specific length of soaking. Vegetable dyeing is also better carried out at boiling point temperature for 30 minutes. This is in line with several studies; Mustard,(1977) Bliss,(1980) and Thurstan,(1949) found similar way in their studies. Lesch,(1969) also reports

that dyebath is made by extracting the colour from the dye plant with boiling water but the process varies slightly. In some, she further reports, the dye plant is covered with water and boiled until the colour is transferred from the dye material to the water while in others the dye materials are soaked and then boiled in the water. To dye the fabric, Lesch,(ibid) reports that it is (the fabric) entered into the dyebath and temperature is raised to a simmer ($180^{o}F$ - $120^{o}F$). This temperature according to her, is maintained for about 20 minutes for light shades of colour and 30 minutes for dark shades of colour.

Based upon the basis of the results of the experiments performed in this study, it was found that mordants did not only help to make the colour stay permanently on the cotton fabric but also varied the shades of colour of the same dye plant. Castino,(1975) and Bliss, (1980) who worked on vegetable dyes and dyeing also report that it is the plant mordant combination that determines the final colour of a dye plant and that various mordants

produce different final results from the same dye plant. Storey,(1976) also reports that vegetable with very few exceptions, have no colouring power except when they are used in conjuction with mordants. Thurstan,(1949) reports that mordanting is quite as important as dyeing, that is, according to her, the success of vegetable dyeing rests chiefly on the mordanting processing. These similar findings reinforce the reliability of findings in the current study.

Bliss,(1980); Lesch,(1969) and Lyttle, (1974) in their studies report that dye plants vary their colours from one geographical region to another. This appears to be partially not true in the current study, especially without the help of various mordants. It was also found that the type of water used in carrying out vegetable dyeing may vary the shade of colour of the same dye plant. This finding appears to be reinforced by Mustard,(1977) who reports that if water from the well is used, it may contain minerals that could darken, as iron does, or otherwise change the colour of the same plant dye.

Bliss,(1980) reports that the most intense dyes will result from the use of freshly picked plants. Thurstan,(1949) in her studies also reports that many plants can be used either fresh or dried, but, according to her, the dye is stronger and the colour more vivid, when they are fresh. This appears to be partially not true in the current study, it only depends on the individual dye plant and mordant used.

5.4 CONCLUSIONS

Based on the results of the experiments performed in this study, it is conclusive that:

1. The most appropriate way by which dyes can be extracted from plants is by soaking the dye material for two to 12 hours, depending on the type of the dye material and boiled for 30 minutes.

2. 20 grams of bixa and turmeric ('magina') are each capable of producing 1.5 grams and 2.7 grams respectively, while 20 grams of onion skins ('albasa') produce about 150 ml. of dye solution.

3. Plant dyes may or may not produce varied results from one geographical environment to another depending on the plant mordant combinations. The type of water used in carrying out vegetable dyeing may also vary the shade of the same plant dye depending on the individual plant mordant combinations.

4. Various mordants produce different final results from the same plant dye as well as making it possible for the dye to penetrate and stay permanently on the cotton fabric hence the colour is fast to light and washing.

5. It can be concluded that mordanting process can be carried out at cold temperature and 30 minutes is enough.

6. From the researcher's personal observation, it can be concluded that there is some correlation between the odour of the plant and the dyebath and the intensity of the dye. Usually the stronger the plant odour, the stronger the dyebath.

7. The use of dried materials as in the case of bixa and 'magina' plants, produced darker shades of colour especially on iron mordanted specimens than when fresh materials were used.

8. Mordanting with tin (stannous chloride) mordant at boiling point temperature for over 30 minutes will break or weaken the cotton fabric.

5.5 IMPLICATIONS OF THE FINDINGS TO TEXTILE EDUCATION

Based on the findings and conclusions of this study, the following are imply to textile education:

1. The availability of vegetable dyes can help the students and teachers of textile at secondary and tertiary as well as those at the university and polytechnic levels to have enough dyes to work with. These dye materials can also be preserved for future use. The availability of vegetable dye from the findings and the conclusions of this study can reduce the financial difficulty faced especially by the textile students.

2. The textile graduates from the Nigerian Universities and Polytechnics do not have to rely so much on the Government or the Textile Industries for employment. Those who wish can grow enough quantity of these dye plants so as to set up their own dyeing workshops or studios which will eventually create job opportunity for the graduating textile students. Such a workshop will also help textile graduates to discover more ways by which dye can be extracted from plants as well as exploring more dye producing plants.

3. Based on the findings and conclusions of this study, the traditional indigo dyers can able to know and have more varieties of colours from these other dye plants rather than depending on the indigo which only produces shades of blue.

4. Factors influencing vegetable dyeing and dyes have been correctly assessed in this study. This can enable those in the dyeing trade, textile students and teachers at secondary, tertiary, polytechnics and university levels to determine the quality and quantity colour a dye producing plant can yield in a certain

geographical environment. The study can also enable those in the textile field to determine the fastness properties of certain plant dyes on cotton fabrics.

5.6 RECOMMENDATION FOR FUTURE RESEARCH

On the basis of the findings and conclusions of this study, the following educational and administrative recommendations for future research are made:

Educational Recommendations

1. More ways of extracting dyes from plants and methods of vegetable dyeing should be explored - caustic soda and hydrosulphite for example, should be tried.

2. The chemical make up of the soil in which the dye producing plant is grown should be analysed by future researchers.

3. Further investigations should be made with respect to the cost of vegetable dyes and dyeing and man-made dyes, the synthetic dyes.

4. Most of the mordants used in this study are not easy to come by especially chrome, copper, tin and iron. In order to substitute some of these mordants, more work should be done on wood ash. Mordanted wood ash dyed fabric should be tested for colour fastness.

5. This study has tried to examine the factors influencing vegetable dyes and dyeing, additional research is required to investigate the same plant material taken at different seasons.

6. Further explorations should be made on more dye producing plants.

Administrative Recommendation

In view of inadequate supply of the synthetic dyestuffs, the state and federal governments and the textile industries (especially those states that textiles industries are located) should encourage the growth of dye producing plants especially dye plants like onion which will not only be served as textile dye but also for consumption.

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APPENDIX: A Map of Nigeria Showing Areas Where Dye Materials Were Collected.

