ASSESSMENT OF COLOUR FASTNESS PROPERTIES OF DYE EXTRACTED FROM GUINEA CORN LEAVES ON COTTON FABRIC

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Abstract

The main objective of thestudy was to assess the colour fastness properties of dye extracted from guinea corn leaves on cotton fabric. Specifically,the objectives were to; assess the light fastness of dye extracted from guinea corn;assess the rubbing fastness of dye extracted from guinea corn;and the washing fastness of dye extracted from guinea corn. Cold maceration and soxhlet extraction were employed using distilled water and acetone as solvents. The dye was produced in four states using distilled water and acetone in mecaration and the yield were wine and slightly deep wine respectively while in soxhlet extraction, distilled water plus sample and acetone plus sample yielded slightly reddish brown and reddish brown. The extracted dyes were applied on cotton fabric treated with alum. The colours after dyeing yielded blush, deep blush, brick and deep brick respectively.Light,rubbing and washing colour fastness were tested using cotton fabric treated with alum. Most of the fabrics dyed with dye extracted using maceration have lower rating on grey scale than those with soxhlet. It is therefore recommended among others that effort should be made in using better yielding techniques in extracting dye for better fastness.

Key words:Extraction,Natural Dye,Aceton,Soxhlet,maceration,guinea corn leaf,colour fastness.

Introduction

Dyes are substances capable of imparting colour to textiles, paper, leather and other materials such as foodstuffs (Yadav,Yadav,and Kharya, 2014). They are also widely employed in pharmaceutical, Cosmetics, photographic.Dyes are used as pH indicators and as biological stains. Mordant dyes improves the fastness of dyes against water,light and perspiration. There are natural and synthetic dycs.

Synthetic dyes are synthesized from petro chemical sources and hazardous chemical processes which pose threat to the environment. William Henry Perkin discovered the first synthetic dye,manveine in 1856 (Mohammadi, Ziarani and Kuruger,2018). This paves way for the production of different pigments. Examples of synthetic dyes are direct,acid,basic,reactive, mordant, metal complex, vat, sulphur, and disperse Researches have shown that synthetic dyes are suspected to release harmful chemical that are allergic, carcinogenic and detrimental to human health (Mansour,2013).This means that they are not eco-friendly. This chemical waste from the synthetic dyes contributes several damages to the ecological system of the receiving surface water,creating a lot of problem to ground water resources. This condition of environmental consciousness had led to the rebirth of interest in natural dye (Kulkama, 2011).There became the necessity to develop

natural dyes as they have better bio-degradability with the environment.

Natural dyes are dyes obtained from plant, leaves, flowers, root, bark, insect secretions and minerals. Since they are nature based,natural dyes are perceived as harmless and safe for the environment. They are non-toxic. non-allergic to the skin,non-carcinogenetic, easily available and renewable (Thiyaparajan, Balakrishn and Tarnilaras, 2015).The use of natural colour for dyeing fabrics has been in practice since ancient time (Ibrahim,Mohammed and Wong, 2013). They were the only dye available to mankind for colouring textiles as far back as 1856 (Sujata and Raja, 2016). Natural dyes exhibit unusual and soft hues compared to synthetic dyes(Tusharbala,Goutam,Pranati and Sanjaya(2012).The inventions of synthetic dyes during 1856 - 1900 negatively affected the market of natural colorants as synthetic dyes were cheaper and possess the quality of excellent fastness and obtainable in variety of shade (Samanta and Konar, 2012). For natural dyes to be efficient in fabric colouration, adequate yield has to be ensured.

Moreover,to ensure adequate yield, proper technical extraction,application of natural dyes,efficient method of extraction and adequate use of solvent must to be employed. This has led to so many research works carried out across the world on the application of natural dyes as important alternative to synthetic dyes (Acgnah and Oduro. 2012).

The African continent is rich in different plant species with potential to produce novel natural products with dye-yielding properties (Wanyama et al, 2014). Guinea corn leaf is a type of plant that can be used for dye extraction. As a plant it is reguiarly available in the natural environment in Nigeria. In extracting dye from the plant, different techniques can be used.Examples of such techniques are maceration and soxhlet extraction. Maceration is a technique used in extracting dyc from plant that involves leaving the pulverized plant to soak in a suitable solvent in a closed container. Cold maceration is done at room temperature by mixing the plant with the solvent and leavingthe mixture for several hours with occasional shaking or stirring. Finally the extract in strained from the plant particles (Mahdi and Altirid,2010).Temperature in maceration can be cold or hot. This type of technique requires no special apparatus like the soxhlet.

Soxhlet extraction is a technique that places a specialized piece of glass ware in between a flask and a condenser. The refluxing soxhlet repeatedly washes the solid extracting the desired compound into the flask.The technique is mostly carried out for colourant identification.The temperature of the instrument is always maintained well under the boiling point of the solvent used. Several cycles of the solvent is run asto extract the entire compound from the plant part for dye application. Osabohien (2009) confirmed that many of the natural dyes have poor affinity for textile materials unless they are treated with mordant,this is why natural dyes need to be tested for colour fastness.

Colour fastness is the resistance of a material to change in any of it's colour characteristics or extent of transfer of its colourant to white material in touch using treatment like washing,light,dry cleaning and rubbing.The colour fastness is usually rated either by loss of depth of colour in original sample or it is also expressed by staining scale (Mormardaslan, 2018). Colour fastness of dyes can be tasted using cotton,wool,linen,polyester etc.Therefore, there is a re-evaluation of ecology as a major trend for influencing colour, and it is believed that naturally dyed fabrics can meet the current global greening movement (Osabohien,2014).Hence the study sought to address the light,rubbing and washing

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fastness properties of dye extracted from guinca com leaves.

Specific Objectives

1 Assess the light fastness of dye extracted from guinca corn leaves.

2. Assess the rubbing fastness of dyc extracted from guinea corn leaves.

2. Assess the rubbing fastness of dyc extracted from guinea corn leaves.

3. Assess the washing fastness of dye extracted from guinca corn leaves.

Research Questions

1 what is the light fastness of dye extracted from guinca corn leaves?

2. what is the rubbing fastness of dye extracted from guinca corn leaves?

3. what is the washing fastness of dye extracted from guinca corn leaves?

The findings of this study will enhance the teaching of textile dyeing/printing in tertiary institution and also motivate new researchers in discovering plants that have good potential of dye extracts for textiles.

The study was delimited to the use of guinea corn leaf in extracting dye using two solvents (Acetone and water) and two techniques (soxhlet and maceration).The scope also embraced the use of Material dyed on the mordant cotton fabric and examined the colour fastness properties

Materials Needed:

The dried leaves of Guinea corn used for the work was purchased from New Market in Aba South,Abia State. The cotton fabric, baking soda, Aceton, and alum were obtained from old market in Aba South of Abia State. All chemicals used as solvent for extraction were of analytical grade and required no purification

Equipment/instrument

Apparatus used for the experiments include: Volumetric flask(100m/,500ml),Beakers of varying sizes,Graduated measuring cylinder of volume size 10,20,25 and 100ml,Soxhlet apparatus, Heating mantle,Weighing balance,Pot,Bath,Rotary evaporator.The equipment were obtained from the chemical laboratory of department of chemistry. University of Uyo,Uyo Akwa Ibom state, Nigeria. Water was provided in the chemistry laboratory.

Treatment of Sample

The plant sample was washed with distilled water to remove dirt's and later checked for final spot on the leaves which may produce adverse effect on the extraction process of the dye stuff. The guinca corn leaves samples were reduced to smaller pieces using knife.

Treatment of Substrate Scouring the substrate:The substrate(White Cotton)was simmered in a solution of dish soap. This removed the oil, wax or dirt that might interfere with dye adhering to the fiber. After,the substrate was rinsed properly.

Mordanting the substrate: In order to charge the substrate to be dyed, potassium Aluminum sulphate which is locally known as alum was used for the treatment. Two litres (2ls) of water was filled in a pot, 1 table spoon (ITb) alum and 1tsp baking soda were added to it plus the substrate. This was brought to a boiling point of 100C with constant starring and simmered for two hours. The substrate (cotton Fabric) was allowed to cool off and soaked in the alum solution overnight.

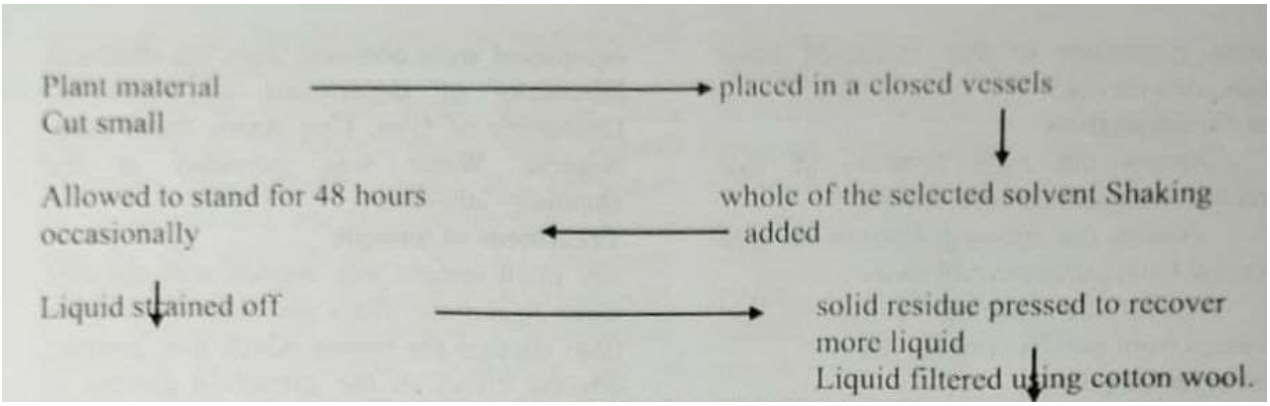
Method of dye extraction

Cold Maceration

100gs of the sample (guinea corn leaves) was added to a beaker (500ml)containing 300ml of distilled water and agitation was done at intervals for 48 hours for complete extraction. The resultant mixture was filtered using cotton wool and filter funnel. Similar experiment was conducted with acctone to compare the extraction power of the solvents.The temperature and the PH of each extract was taken and recorded.

Maceration process

General procedure



(Adapted from Mahdi and Altikriti,2010)

Soxhlet Extraction

The dried leaves of guinea corn were gathered chopped into smaller pieces measured quantities of pulverised samples were fed into the soxhlet cxtractor This method of extraction is carried out when a compound of low solubility needs to be extracted from a solid mixture. This technique places a specialized piece of glassware in-between a flask and a condenser.The refluxing solvent repeatedly washes the solid extracting the desired compound into the flask. The soxhlet extraction was carried out for colorant identification.Soxhlet extractor comprises of the condenser, thimble, siphon tube, solvent tube, round bottom flask and the heating mantle.100g of each of the sample was measured into the thimble and 300ml of acetone was added into the round bottom flask fitted into the thimble for extricable. The heating mantle was on and extraction was done for 6 hours on sample and the temperature for extraction was 56.05 c on the sample which is the boiling point of acetone. The same procedure was used for the extraction using water as solvent with a temperature of 100c. Several cycles of solvent were run so as to extract all the compound from the leaves. Rotary Evaporator was used to remove excess solvent leaving the dye in dry state.

Dyeing Procedure

All the extracts were obtained in both aqueous and powder form. 5g of the concentrate dye from the leaves of guinea corn was mixed with 100ml of distilled water and acetone respectively for the dyeing process. The proportion of the fabric to be dyed with the dye mixture were constant in all the operations. The measurement of the fabric were 47cm by 25cm.100ml of the liquid dye was measured into a 250ml beaker, the fabric was submerged into the beaker, the fabric heated between 40-60'c and stirred approximately for 20 minutes respectively. The dyed fabric was removed and aired for oxidation to take place for five minutes.They were rinsed separately in running water and dried under a shade.

Fastness properties of dyed fabrics

Light fastness

Two sets of dyed mordanted fabric were prepared.One set was exposed to sunlight for two weeks while the second set was kept in the dark wrapped in a bag.The exposed ones were rated to the unexposed fabrics on a gray scale (Osabohien and Ukponmwan, 2002: Osabohien 2014).This was carried out in the absence of the Amercian Association of Textile Chemists and Colourists (AATEC)standards.

Washing fastness

Two sets of dyed fabrics were washed using mild soap solution at different temperatures and time.The fabric dyed with dye obtained

from maceration technique and the another set dyed with dye obtained through soxhlet technique. The two sets were rated according to their different washing fastness. The treated fabrics were compared with the untreated fabrics in a gray scale.

Rubbing fastness

This was carried out in two sets. The fabics dyed with dye obtained from maceration and fabrics dyed with dye obtained from soxhlet.

The rubbing was subjected to different time and temperature. The sample fabrics were rubbed respectively between white cotton of the same size of 10cm by 5cm.Two set wet and dry rubbing fastness were carried out. The two set of treated fabrics were rated according to their different rubbing fastness. The treated fabrics were compared with the untreated fabrics in a gray scale.

Results and Discussion

Table I:Extraction of dye through mecaration

Material	Technique	Temperature32℃	PH55	Time48hours48hours	Yield38.6%49.8%
Guinca comn leavesGuinca Corn leaves	Water Maceration Acetone Maceration	32℃			

Table I revealed that in water maceration the dye yield was 38.6% under 32'C with PH 5 and the time observed was 48 hours. Table 2: Extraction of dye through soxhlet.

For acetone maceration the yield was 49.8% maintaining the same temperature and PH.

Material	Technique	Temperature100℃	PH55	Time6hours6hours	Yield52.1%61.8%
Guinea Com leavesGuinca Corn leaves	Water soxhlet Acetonc Soxhlet	56.05			

Table 2 showed result on soxhlet extraction.

The water soxhlet of the plant at 100℃ within the PH of 3 gave the yield of 52.1% and the time observed for the experiment was 6 hours. For acetone soxhlet the temperature was 56.05 as the boiling point and the same PH and time was maintained. It gave dye yield of 61.8%.

Table 3: Colour of dye obtained with different solvents and method of extraction

Material Technique	Type o f PH	Temperature	Colour observed	Colour observed

		textile			after filtration	after dyeing
Guinea	Water	white	5	32℃	Wine	Blush
Com	maceration	cotton				
Leaves						
	Acetone	white	5	32℃	Slightly reddish	Brick
	maceration	colton			brown	
Water		white	5	100℃	Slightly deep Wine	Deep blush
	soxhlet	cotton				
	Acctone	white	5	56.05	Deep reddish brown	Deep brick
	soxhlet	cotton				

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Table 3 revealed the colour obtained from different solvents and methods. For water maceration colour observed after filtration and dyeing were wine and blush. In acetone Light fastness maceration it was slightly reddish brown and brick.The water soxhlet gave slightly deep wine and deep blush after filtration and dying while acetone soxhlet gave deep reddish brown and deep brown.

Table 4: Light fastness properties of fabric dyed by maceration and soxhlet methods

TechniquesWater	Colour	Time	Light fastness
			(Gray scale)3-4
macerationAcetone		2 weeks	3-4
	ObtainedBlush	2 weeks	
macerationWater			3-4
	Brick	2 weeks	
soxhlet	Deep blush	2 weeks	3-4
Acetone soxhelt	Deep brick		

1-2 most colour change;2-3 colour change;3-4 slightly colour change;4-5 colour retained.

Table 4 showed that the colour changed as exposed of the fabric sampled to sunlight for two weeks resulted in a light change in colour.When compared with the untreated fabric,the table revealed that both fabrics dyed with dye obtained from maceration and soxhlet all had a slight change in colour of 3 4 as rated in the gray scale. Table 6 answered rescarch question

Washing fastness

Table 5:Washing fastness properties of fabric dyed by maceration and soxhlet Methods

Time(min)	Temperature(℃)	Maceration	Soxhlet
60	40	4	4-5
	50	4	4
	60	4	4
90	40	3-4	4-5
	50	4	4
	60	3-4	4
120	40	3-4	4
	50	3-4	4

60		3.4

1-2 most colour change;2-3 colour change;3-4 slight colour change;4-5 colour retained.

The washing fastness revealed in Table 5, shows that fabrics dyed with dye obtained from maceration technique were rated between very good to good. Their ratings were 4 and 3 4 receptively at different temperatures but for washing time of 60 minutes they were rated 4 (very good).For 40 and 120 minutes they were rated between Rubbing Fastness very good and good.For fabrics dyed with dye obtained through soxhlet method were all rated very good in their washing fastness. it was observed that fabrics dyed with dye obtained through soxhlet method have a higher washing fastness rating than fabric dyed with dye obtain through maceration technique.

Table 6: Rubbing fastness of fabrics dyed by maceration and soxhlet methods

Time(min)	Temperatre(℃)	Maceration		Soxhlet	
		Dry	Wet	Dry	Wet
60	40	4	3	4-5	4
	50	4	3-4	4-5	4
	60	4	3-4	4-5	4
90	40	3-4	3	4	3
	50	3-4	3	4	3
	60	3-4	3	4	3
120	40	3-4	3	4	3
	50	3-4	3	4	3
	60	3-4	3	4	3

1-2 most colour change,2-3 colour change,3-4 slight colour change,4-5 colour retained.

Table 6 shows the rubbing fastness for fabrics dyed with dye obtained from the leaves of guinea com using cold maceration and soxhlet technique in relation to dry and wet rubbing fastness in Table 5 revealed that mordanted cotton fabric dyed with dye obtained through cold maceration for dry rubbing fastness ratings fall between 3 to 4 at different temperature and time.While for wet rubbing fastness the ratings were 3 for

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temperatures 40,50 and 60 within 90-120 minutes while for 60 minutes, the wet rubbing fastness was 3-4 for temperature 40,50 and 60 withn 60 minutes. For fabrics dyed with dye obtained from soxhlet method, it was observed that for temperatures 40, 50 and 60 within 60 minutes the dry rubbing fastness rated 4-5 which is very good to excellent while at temperature 40, 50 and 60 in 90 - 120 minutes it rated very good. But for wet rubbing fastness,temperatures 40, 50 and 60 in 60 minutes time rated very good and the remaining under 90 -120 minutes rated good.

Discussion

The dye sample from the leaves of guinea corn was found soluble in distilled water and acetone. It was observed that the dye concentration was high in the soxhlet extraction. This supports the fact that soxhlet extraction is a very efficient form of extracting colour from solid materials (Vankar, 2016). It may also be as a result of the temperature as the heat of the solvent comes in contact with plant, the extracting power was more efficient. Temperature is the main factor which affects the extraction efficiency of dye from natural plant (Kan. Uma and Rajarathinam, 2015). At higher temperature water and acetone was able to extract larger yield of natural dyes. The hues obtained by maceration using acetone as the solvent gave brick and deep brick compared to maceration using water as solvent which gave blush and deep blush. It also supports the fact that maceration is preferable used with volatile solvent (Hans-Jorg,2016).The temperatures of the various extracts were taken during extraction and dyeing. The variation in temperature ranges from 30-100c at PH 5. The variation in temperature range for maceration was 32-60c while for soxhlet was 56-100c. The difference in temperature between the distilled water and acetone is that acetone is very high in volatility (Usoro, 2001).

The colour observed after filtration and dyeing revealed distilled water plus sample in maceration as blush,Acetone + Sample in maceration as brick, distilled water plus sample in soxhlet deep blush and acctone plus sample in soxhlet as deep brick. For the methods employed,rubbing fastness decreased by the increasing the duration of dycing and temperature.This may be due to decomposition of dyes at higher temperature of prolonged dyeing period (Nagia and El-Mohanedy,2007).Most of the fabrics dyed with dye extracted using maceration have lower rating than those with soxhlet.

The dye yields were not too fantastic which is the characteristics of natural dyes (Osabohien, 2009) The fabrics dyed with dyes obtained through soxhlet techniques showed better light, wash and rubbing properties compared to fabrics dyed with dyes obtained through maceration technique. Conclusion

This work showed that different hues of dye can be extracted from the leaves of Guinea corn.The process of the extraction was eco-friendly.The dye hue obtained has the dyeing potential which can be used as a source of textile dyeing. The colour shade can be obtained using different methods and different solvents. The research work unveiled that their properties are preferable to synthetic dye as they are not toxic.The use of mordant in textile application is found to be fruitful to improving colour shades of the dyes. Guinea corn leaf is a very good plant part that serves as a source of raw material for obtaining yellow dye that can be used for fabric dyeing in future. Fabrics dyed with dye extracted through soxhlet technique have better colour fastness than the one extracted by maceration.

Recommendations

1. The clothing and textile sections in secondary schools, colleges of

education and universities can use the result of the study as a resource material for teaching creative skills in dyeing fabric, fibres, yarms,tie-dye,batik etc.

2. Instructors should use the study to educate the student on the use of dye that is ecofriendly.

3. The government should sponsor research work on natural dye exploration as this will help to safe guard our environment from the damage caused by the use of synthetic dyes.

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