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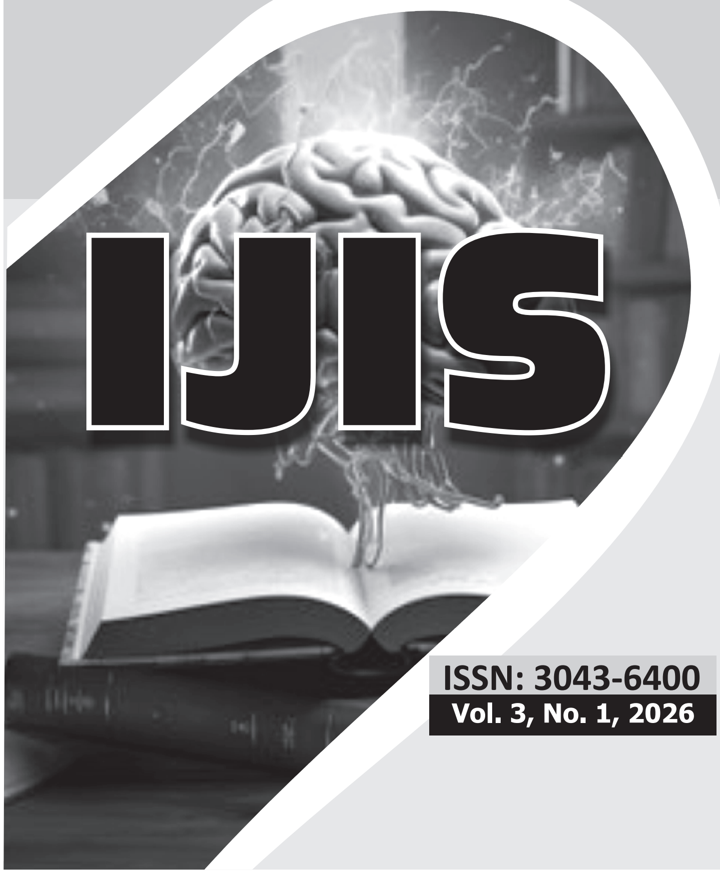

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ASSESSMENT OF DYESTUFFS FROM *S.* BICOLOR LEAVES AND H. SABDARIFA CALYCES ON COTTON FABRIC

ABDULQUADIR, I. O. & ASIFAT, B. R.

ASSESSMENT OF DYESTUFFS FROM *S.* BICOLOR LEAVES AND H. SABDARIFA CALYCES ON COTTON FABRIC

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Abstract

The study assessed the dye yield, colour fastness properties, and organoleptic acceptability of dyestuffs extracted from Sorghum bicolor leaves and Hibiscus sabdariffa calyces on cotton fabric. A Research and Development (R&D) design was adopted. Dye extraction was carried out using aqueous and methanolic solvents, followed by mordant-assisted dyeing on 100% cotton fabric. Standard ISO procedures were used to evaluate wash, rub, and light fastness, while organoleptic acceptability was assessed using a structured rating scale. Results showed that aqueous extract of H. sabdariffa produced the highest yield (31.66%), while aqueous extract of S. Bicolor produced the lowest (8.31%). Fastness properties varied across samples, with moderate wash fastness but generally poor light fastness. Organoleptic evaluation revealed that fabrics dyed with aqueous extract of H. Sabdariffa had the highest consumer acceptability. The study concluded that both plant sources are viable natural dyes, though improvements in fastness properties are necessary for industrial application.

Keywords: Natural dyes, colour fastness, cotton fabric, sorghum, roselle, sustainability

Introduction

Dye is a coloured substance that has an affinity for the substrate to which it is being applied. It is generally a colour that stains specific materials (Bishal et. al., 2023). (Ekeh, and Okoronkwo, 2016). However, dyes have been used to alter the appearance of cloth and fabric by changing their colour since ancient times. Being organic chemical compound which imparts permanent colour to other materials, dyes however are either natural from natural sources or synthetic from chemical industries. Samantha (2020) postulated that natural dyes are known to be used since historic times for coloring food substrate, leather, as well as common textile fibers like cotton, wool and silk. However, due to the advent of synthetic dyes and their good fastness properties in comparison to natural dyes, the use of natural dyes have suffered drastically. Presently, there has been a rise in concern of eco-friendliness and sustainability of the products used by the consumers for which natural dyes are again starting to gain more popularity. They are obtained from natural sources such as plants, animals, fungi, microbes, minerals (Bishal et. al., 2023) and man-made sources which are generally referred to as synthetic dyes. Nigeria has abundant resources in terms of plants which contain dyes in parts such as the roots, bark, leaves, seeds, fruits and flowers and one of such plant is guinea corn (Nwoye and Ezema, 2017). Sorghum bicolor and roselle are typical plants that serve as one of the major farm waste in Nigeria as they are still under-utilized (Abdulquadir and Adebisi, 2023).

Sorghumbicolor (Guinea corn) belongs to the grass family, Poaceae. Guinea corn leaf is an important source of carbohydrate, protein and minerals such as calcium, selenum, manganese and iron in which the bioavailability depends on the level of interactions with various anti-nutrients, the leaves of which constitutes greatly to farm wastes in Nigerian farm. Akorede-Oloye (2024) opined that Sorghum bicolour (guinea corn) is so named due to the inherent colours possessed by the plant. She added that the reddish brown colour is physically seen on every part of the plant and these were used for coloring and this feature however is an evidence that sorghum corn is high in tannin The plant is also known as Soursour in Sierra Leone, dab or bissap in Senegal and surrounding countries, roseille de Guinean or Roselle in

French, marakwanga in Northern Uganda, Jamaican sorrel or Florida crambery in the Caribean areas (Yılmaz, and Bahtiyari, 2017). Another important plant that is yet to be fully employed in textile dyeing is roselle. On the other hand, *Hibiscus S.* (Roselle) plant is a tetraploid belonging to the family Malvaceae (Yakasai et. al. 2021). Ozougwu and Anyakoha (2013) asserted that roselle plant has been extensively utilized for various purposes for making beverages, manufacture of newsprint and found useful in medicinal and pharmacological fields and for making food colourants but has not been adequately explored for its dye for fabric colouration despite its large pigment content.

Osabohien (2014) carried out a study on the extraction and application of dyestuffs from the leaves of guinea corn and onion skin that discovered that fabric dyed with the extracts showed different colour shades, hues and improved wash and light fastness with mordanting. Also, Ozougwu and Anyakoha, (2016) revealed that Hibiscus sabdarifa dye has good organoleptic attributes and could be used for 100% cotton fabric colouration. Nwonye and Ezema (2019) dye extracts from guinea corn leaf are eco-friendly which can be used as a source of textile dyeing and food colouring. Also, Abdulquadir and Adebisi, (2023) revealed that S. bicolor and H. sabdarifa are good sources of natural plant dyes as they are rich in colour yielding compounds. Akorede-Oloye (2024) conducted a study on the extraction and characterization of guinea corn plant extract for mordant assisted dyed cotton fabric. The study revealed that ethanol is a more proper and suitable solvent than aqueous extraction this is because it produces more yield of dye and the application of mordants in fixing dyes into the fabrics improve the colour shades and fastness properties of the dyes thereby enhancing their aesthetic value. Finally, Abdulquadir and Abdulkadir (2025) added that Sorghum bicolor and Hibiscus sabdarifa are good sources of natural dyes as they are rich in colour yielding compounds and good for textile dyeing with appreciable colour.

Statement of the Research Problem

The textile industry is under increasing pressure to adopt sustainable practices, particularly in the area of dyeing, where synthetic dyes often pose environmental and health risks. Natural dyes, extracted from plant sources, offer a promising alternative due to their biodegradability, low toxicity, and renewable nature. Sorghum bicolor (commonly known as sorghum) leaves and Hibiscussabdariffa (roselle) calyces are abundant agricultural by-products known to contain potent natural pigments. Despite their potential, comprehensive studies on their yield, color fastness, and acceptability on cotton substrates remain limited.

While natural dyes are environmentally friendly, their industrial application is hindered by inconsistent dye yields, variable fastness properties, and uncertain consumer acceptance. For proper integration of natural dyes into mainstream textile production, there is a need to solve this problem of inconsistencies in dye yield as well as variable fastness properties. It appears that there is a scanty information on assessment of dyestuffs from S. Bicolor Leaves and H. Sabdarifa Calyces on Cotton Fabric. Hence, this research proposes a systematic assessment of dyestuffs from S.bicolor Leaves and H. Sabdarifa Calyces on Cotton Fabric.

Research Objectives

The main objective of the study is to evaluate the yield, colour fastness and organoleptic acceptability of dyestuffs from *S. bicolor* leaves and H. sabdariffa calyces on cotton fabric.

Therefore the specific objectives were to:

a. examine the extraction yield of dyestuffs from S. bicolor leaves and H. sabdariffa calyces.

b. determine the color fastness properties of cotton fabric treated with dyestuff extracted from S. bicolor leaves and H. sabdariffa calyces

c. investigate the organoleptic acceptability of cotton fabric treated with dyestuff extracted from *S. bicolor* leaves and *H. sabdariffa* calyces

Materials and Methods

Dried Leaves of Sorghum b. and Hibiscus S. was purchased, methanol (absolute), distilled water, mortar and pestle, sieve, knife, spatula, weigh balance, beakers, flasks, measuring cylinder, funnel, and bowls was used for the dye extraction and application.

Extraction

Pre-treatment: Cleaning and drying of plant materials.

Dye Extraction: Solvent extraction was used for the extracting the dye (Lizamoni, *et. al.,* (2021) and Salauddin, *et.al.,* (2021) the collected dried Sorghum B. leaves was chopped into smaller bits 1000g of this was added to 5000ml of methanol (absolute) and then left for three days. This will then filtered using a cotton fabric and a filter funnel. The filtrate was kept airtight in a container. Dried calyces of *Hibiscus S. was* milled and then 1000g of this was added to 5000ml of methanol (absolute) then left for three days. Extraction parameters (temperature, time, solvent-to-material ratio) was optimized to maximize yield. This was then filtered using a cotton fabric and a filter funnel. The filtrate was be kept airtight in a container labeled as samples SBM and HSM for methanol dye extracts from *S. bicolor* leaves and *H. sabdarifa* calyxes respectively. The same process was followed using water as the solvent, the filtrates in this case are labeled SBW AND HSW.

Yield Measurement: Calculated the extraction yield (percentage yield relative to the dry weight of the raw material).

Dye Application

Fabric Treatment: 5 yards of cotton fabrics was scoured in warm soapy water so as to remove the fabric finishes applied on fabric.

Mordanting: Pre-treated fabrics using selected eco-friendly mordants to improve dye uptake 50g of alum and 10g of table salt).

Dyeing Method: contemporary plain dyeing method (Ozougwu and Anyakoha, 2016) was adopted for the dye application. The dye bath was prepared with 50g of alum and 10g of table salt was dissolved in 500ml of boiling water then 120ml of the dye liquor was then added. The fabric was immersed in the dye bath for 45minutes and then removed and dried in an airy shady place. This procedure was repeated for the remaining samples with adequate control dyeing variables (temperature, pH, and time).

Post-Dyeing Treatment: Rinsing and drying of the dyed fabrics.

Determination of Colour fastness
Wash Fastness

Preparation of specimen for testing: Measure 10cm by 4cm of the dyed / printed fabric and conditioned to standard atmosphere. Place between two pieces of white (undyed) cloth and sew along all the sides in the specimen(s) with 5cm by 4cm exposed. This forms the composite specimen.

Preparation of The Soap Solution: The soap solution is prepared based on the weight of the fabric (composite fabric). Weigh 5g soap / litre of distilled water previously heated to 50 + 20c and liquid ratio of 50:1 depending on the weight of specimen (s) for testing.

The specimen is treated in soap solution at liquor ratio of 50:1 for 30 minutes under the following ISO Test conditions as shown below;

ISO Test 2 500c+ 20c

2g/litre anhydrous sodium carbonate is added to the soap solution of the ISO Test No 2. The composite specimen mentioned earlier (5) is placed in the wash –wheel container or hand washing machine with ten steel balls and enough soap solution of 5g/litre and 2g/litre anhydrous sodium carbonate. After the required time and temperature, rinse twice in cold distilled water and rinse in cold running tap water for 10 minutes and squeeze it. Remove the stitch along the two long sides and one short side. Open out the composite specimen and dry in the air at temperature not exceeding 600c with the three parts in contact. Then assess the stain of the undyed cloth and the colour on the specimen using grey scale.

The Grey scale was then used to assess the degree of staining on the white sample both when dry and when moistened. Similarly, use the gray scale to assess the sample for change of shade of the coloured specimen.

Light Fastness

Colour Fastness To Day Light: The Blue wool light fastness Standards (1-8) were cut into strips of 5cm by 1cm and stapling them across a black cardboard of 10cm by 5cm was done. Cut the specimen into the same size as the Blue scales strip and staple it along with the Blue scale standard simultaneously for 24 hours per day with protection from weathering. The blue scales standard 1-8 were used as control to the test. Checking the effects of light on the specimen (s) by removing the cover and inspecting the specimen (s) until a change was seen on the specimen was carried out. The number of the standard (1-8) showing a particular change was noted. The exposure until standard 7 on the Blue wool scale fade to a contrast equal to 4 of the Grey scale, when this occurred, the exposure was terminated.

Also, colour fastness to An Artificial Light Source: the specimen were cutas described in the day light procedure. This time, the specimen and the blue wool light fastness scales placed across the black cardboard paper are fastened into the specimen holder and placed into the cell where they are exposed to the light.

The covers that were used to protect the samples were removed from weathering showing the samples standards- the exposed and unexposed area to light. The results were obtained by comparing the faded specimen (s) with those of the Blue standards. Any one of them showing a similar changes of shade is noted and its number will represent the degree of fading of the tested specimen (s). The fastness to light ratings are as follows; 1 very poor, 2 poor, 3 moderate, 4 fairly good, 5 good, 6 very good, 7 excellent, and 8 outstanding.

Rub Fastness

Dry Rubbings Fastness Test: the coloured specimen are placed on the flat bed of the stain tester. Fastening of the white specimen on the rubbing head using the rubber rings was done. Release of the rubbing head from its hook and positioning it on the surface of the dyed material on the flat bed. Then, turn the crank 20 turns producing 40 reciprocal turns of vertical shaft. When the tester is electronically controlled activate the electric motor of the machine and press the rubbing button to allow the machine make several working cycles. After, remove the stained white cloth from the rubbing head and assess using the Grey scale.

Wet Rubbing fastness Test: The dyed fabric was placed on flat bed of the stain tester as described above. The white cotton was wetted with distilled water so that when reweighed it has water retention of 95% - 100%. After the test, the wet stained specimen air – dried and assessed with the grey scale.).

The Grey scale was used to assess the degree of staining on the white samples both when dry and when moistened and assess the samples for change of shade of the coloured specimen.

The instrument that used for data collection is Organoleptic Attributes Acceptability of Treated Fabric Evaluation (OAATFE), which was adapted for this study, with a rating scale of 1-5 with 5 Very highly Accepted (VHA), 4 Highly Accepted (HA), 3 Averagely Accepted (AA), 2 Unaccepted (U) 2 and 1 Highly Unaccepted (HU). Reliability of instrument was trial-testedon 20 respondents and the data was tested at 0.05 Cronbach alpha level of significance and found reliable at 0.85. The instrument however was validated by 5 experts in the field clothing and textiles.

Data Collection

Instrumental Analysis: Compare color uniformity, brightness, and hue consistency using grey scale

Consumer Surveys: A scorecard was developed to gather feedback

Samples	Yield (g/100g)	Percentage yield
SMB	112.50g	22.5%
HMS	136.95g	27.39%
SWB	41.53g	8.31%
HWB	158.33g	31.66%

Source: Lab Work, 2025

Table 1 shows the yield of dyestuffs from aqueous and methanolic extracts of s. bicolor leaves and h. sabdariffa calyces. It revealed that dye yield varies significantly with solvent type and plant source. The highest yield (31.66%) was obtained from aqueous extract of H. sabdariffa, indicating strong water-soluble pigments such as anthocyanins. Conversely, aqueous extract of S. bicolor recorded the lowest yield (8.31%), suggesting limited pigment solubility in water. Methanol extraction improved yield for both plant sources, supporting findings that organic solvents enhance pigment recovery.

Table 2: Fabric Characteristics and Dye Types Used

S/N	Fiber Type	Fiber %	Dye Type	Dye Code	Fabric structure
1	Cotton	100	Methanolic extract from S. bicolor	SMB	Jacquard weave
2	Cotton	100	Aqeous extract from S. bicolor	SWB	Jacquard weave
3	Cotton	100	Methabolic Extract From H. Sabdariffa	HMS	Jacquard weave
4	Cotton	100	Aqeous Extract From H. Sabdariffa	HWS	Jacquard weave

Source: Lab Work, 2025

Table 2 shows the fabric characteristics and dye types used. It was revealed that all samples were applied on 100% cotton fabric, which is known for high dye affinity due to its cellulose structure. The use of jacquard weave enhances aesthetic appearance and dye absorption uniformity.

Table 3:Wash Fastness Properties of Samples Using the Grey Scale

Sample code	No. of Test	Rating	Remarks	Change in Colour Shade (Rating)	Remarks
SMB	1	3	Fair	2	poor
	2	2-3	Slightly fair	2	poor
	Average	3	Fair	2	poor
SWB	1	3	Fair	1	Very poor
	2	3	Fair	1	Very poor
	Average	3	Fair	1	Very poor

Sample code	No. of Test	Rating	Remarks	Change inColour Shade(Rating)	Remarks
HMS	1	3	Fair	1	Very poor
	2	4	Very Good	1	Very poor
	Average	4	Very Good	1	Very poor
HWS	1	4	Very Good	1	Very poor
	2	4	Very Good	1	Very poor
	Average	4	Very Good	1	Very poor

Source: Lab Work, 2025

KEY:
SMB: Methanolic extract of ***S. bicolor*** **leaves**
HMS:Methanolic extract of ***H. sabdariffa*** **calyces**
SWB: aqueous extract of ***S. bicolor*** **leaves**
HWB: Aqueous extract of ***H. sabdariffa*** **calyces**

Table 3 above shows the wash fastness properties of samples using the grey scale. The table revealed that methanolic and aqueous extracts of H. sabdariffa showed superior colour retention (rating = 4), indicating better dye fixation. However, staining resistance was poor across all samples, suggesting weak dye-fibre bonding despite mordant use.

Table 4: Rub fastness test rating of the sampled fabric

Sample code	Grey scale Rating and Remarks			
	Dry fastness test	**Remarks**	**Wet fastness test**	**Remarks**
SMB	4	Very Good	1	Very poor
SWB	4 - 5	Very Good	2	poor
HMS	4 – 5	Very Goo	1	Very poor
HWS	5	Excellent	2	Poor

Source: Lab Work, 2025

KEY:
SMB: Methanolic extract of ***S. bicolor*** **leaves**
HMS:Methanolic extract of ***H. sabdariffa*** **calyces**
SWB: aqueous extract of ***S. bicolor*** **leaves**
HWB: Aqueous extract of ***H. sabdariffa calyces***

Table 4 reveals the rub stain test rating of the sampled fabrics. It was revealed that dry rubbing fastness was generally rated very good – excellent (4-5), indicating strong surface dye adherence. However, wet rubbing fastness was poor, suggesting that dyes are easily removed in the presence of moisture.

Table 5: Light Fastness test of the sampled fabric using the Blue Wool Standard rating and Grey scale rating for change in colour shade of the fabrics.

Sample	Evenness of Shade	Texture (Sight)	Texture (Tactile)	Perceived Quality	Fabric Aesthetic	Overall Satisfaction
SMB	2.90 + 0.66	2.93 + 0.52	3.00 + 0.58	3.10 + 0.60	3.03 + 0.84	3.30 + 0.53
SWB	3.80 + 0.66	3.63 + 0.88	3.67 + 0.80	3.43 + 0.62	3.77 + 0.93	3.87 + 0.57
HMS	3.47 + 0.68	3.27 + 0.63	3.13 + 0.50	3.10 + 0.92	3.30 + 0.87	3.37 + 0.49
HWS	4.067 + 0.58	3.887 + 0.62	3.73 + 0.87	3.77 + 0.72	3.90 + 0.92	4.17 + 0.70

Source: Field Work, 2025

KEY:
SMB: Methanolic extract of ***S. bicolor* leaves**
HMS:Methanolic extract of ***H. sabdariffa* calyces**
SWB: aqueous extract of ***S. bicolor* leaves**
HWB: Aqueous extract of ***H. sabdariffa* calyces**

Table 6 above depicts mean and standard deviation of the organoleptic acceptability of fabrics treated with dyes. It was revealed that the aqueous extract of H. sabdariffa (HWS) recorded the highest overall satisfaction (4.17), indicating strong consumer preference. This suggests that visual appeal and colour uniformity significantly influence acceptability.

Discussion of Findings

The results in Table 1 clearly indicate that both plant sources and solvent types significantly influence dye yield. The aqueous extract of H. sabdariffa (HWS) recorded the highest yield (31.66%), suggesting that its dominant pigments - primarily anthocyanins - are highly water-soluble. This observation is consistent with recent findings that anthocyanin-rich plant materials exhibit enhanced extraction efficiency in polar solvents such as water (Adeel et al., 2023). The results indicate that aqueous extract of H. sabdariffa (HWS) produced the highest yield (31.66%), suggesting strong solubility of its pigments in water. Conversely, aqueous extract of S. bicolor (SWB) recorded the lowest yield (8.31%), indicating poor extraction efficiency in water. Methanol extraction improved yield for S. bicolor, confirming findings by Akorede-Oloye (2024) that organic solvents enhance pigment extraction yields and improve colour shades and fastness properties of the dyes.

Conversely, the aqueous extract of S. bicolor (SWB) produced the lowest yield (8.31%), indicating limited solubility of its pigments in water. However, methanolic extraction improved the yield of S. bicolor (22.50%), supporting the assertion that organic solvents enhance the extraction of less polar compounds such as tannins and flavonoids (Kiumarsi et al., 2023 and Akorede-Oloye, 2024).

The variation in yield between the two plant sources further reflects differences in phytochemical composition. H. sabdariffa is known to contain higher concentrations of extractable pigments compared to S. bicolor, which explains its superior performance. Finally, these findings corroborate Abdulquadir and Adebisi (2023), who reported that S. *bicolor* and *H. sabdarifa* are good sources of natural plant dyes as they are rich in colour yielding compounds.

The results across Tables 3–5 reveal that colour fastness properties vary depending on dye source and test condition, with generally moderate performance.

Wash Fastness: Fabrics dyed with H. sabdariffa extracts (HMS and HWS) demonstrated better colour retention (rating = 4) compared to S. bicolor extracts (rating = 3). This suggests stronger dye-fibre interaction, possibly due to the presence of reactive anthocyanin compounds. However, staining on adjacent fabrics remained poor across all samples, indicating weak fixation and dye bleeding. This aligns with findings by Shahid and Mohammad (2023), who noted that natural dyes often exhibit poor wash durability without advanced mordanting.

Rubbing Fastness: Dry rubbing fastness was generally very good to excellent (ratings 4–5), indicating that dyes adhered well to the fabric surface under dry conditions. However, wet rubbing fastness was consistently poor, confirming that moisture weakens dye-fibre interactions. This behavior is typical of natural dyes, which rely on weaker physical bonds such as hydrogen bonding (Samanta & Agarwal, 2022).

Light Fastness: Light fastness was poor across all samples, with ratings ranging from 1 to 2. This indicates high susceptibility to photo degradation. Natural dyes, especially those containing anthocyanins, are known to degrade under UV exposure due to chromophore breakdown (Adeel et al., 2023). The slightly better performance of S. bicolor extracts may be attributed to tannin content, which provides limited UV resistance.

Finally, the findings confirm that while natural dyes are environmentally sustainable, their fastness properties remain encouraging yet inferior to synthetic dyes, necessitating further optimization this agrees with Osabohien (2014) discovered that fabric dyed with the extracts from plant sources showed different colour shades, hues and improved wash and light fastness with mordanting.

The organoleptic evaluation results indicate that consumer acceptability varies significantly across dye types, with aqueous extract of H. sabdariffa (HWS) achieving the highest overall satisfaction (4.17). This suggests that respondents preferred its colour uniformity, brightness, and aesthetic appeal.

The relatively lower ratings for S. bicolor methanolic extract (SMB) may be attributed to uneven dye distribution and dull colour shades. These findings highlight the importance of visual aesthetics in textile acceptance, as consumers tend to prioritize colour vibrancy and uniformity.

The results support previous studies (Abdulquadir & Adebisi, 2023), which reported high acceptability of roselle-based dyes due to their bright and appealing colour tones. Furthermore, the findings reinforce the argument that despite limitations in fastness, natural dyes possess strong market potential due to their aesthetic and eco-friendly appeal.

Conclusion

This study evaluated the dyeing performance of natural dyes extracted from Hibiscus sabdariffa calyces and Sorghum bicolor leaves on cotton fabrics, with full focus on dye yield, colour fastness, and organoleptic properties. The findings established that both plant sources are effective natural dyes with distinct strengths. Hibiscus demonstrated a higher dye yield and produced brighter, more aesthetically appealing colours, making it suitable for decorative and visually driven textile applications. On the other hand, guinea corn exhibited superior colour fastness to washing, rubbing, and light, indicating greater durability and suitability for functional and long-lasting textile products.

The results further emphasized the importance of mordants in improving dye uptake and fixation on cotton fabrics. Generally, a clear trade-off exists between aesthetic quality (hibiscus) and durability (guinea corn). Despite some limitations, particularly in the fastness properties of hibiscus, both dyes proved to be viable alternatives to synthetic dyes, reinforcing their relevance in sustainable textile production.

Recommendations

Based on these findings, these recommendations are raised:

1. First, the study confirms that natural dyes from hibiscus and guinea corn hold strong potential for eco-friendly textile production, particularly when their individual strengths are strategically combined and optimized.
2. blending hibiscus and guinea corn dyes should be explored to achieve a balance between colour vibrancy and durability.
3. Second, further research should focus on optimizing mordanting techniques and exploring alternative mordants to enhance dye fixation and overall performance.
4. Third, standardization of extraction and dyeing conditions is necessary to ensure consistency and reproducibility of results.
5. Finally, there is also a need for pilot-scale studies to assess the economic and technical feasibility of large-scale production.
6. Finally, further exploration of other locally available plant

materials is recommended to expand the range of sustainable natural dye sources.

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Reference

Abdulquadir, I. (2018). Extraction Application and Acceptability Dyestuffs from *Sorghum bicolor* Leaves and *Hibiscus sabdarifa* Calyces on Cotton Fabric. Unpublished Undergraduate Theses Submitted to the Department of Home Economics and Food Science, University of Ilorin, Kwara State, Nigeria.

Abdulquadir, I. O. and Abdulkadir, S. O. (2025). Sustainable fabric dyeing: analysis of colour properties and acceptability of cotton fabrics dyed with dyestuffs Extracted from selected plants. *Nigerian Journal of Textiles (NJT)*. 11: 14 – 20.

Abdulquadir, I.O. and Adebisi, T. T. (2023). Assessment of *Sorghum bicolor* Leaves and *Hibiscus sabdarifa* calyces as dye on cotton fabrics for wealth creation in post-covid-19 period. *International Journal of Family and Consumer Sciences*. 11.21-33.

Adeel, S., Habib, N., & Kiran, S. (2023). Sustainable dyeing of cotton using plant-based dyes. *Journal of Cleaner Production*, 385, 135678.

Akorede-Oloye, M., Arawande, J., Obinwa, H., Jabar, J., Oderemi, J., Oyegoke D., and Quadri, I. (2024). Extraction and Characterization of Guinea Corn Plant Extract for Mordant Assisted Dyed Cotton Fabric. *GSC Advanced Research and Reviews.* 19(03), 074–085.

Bishal, A., Ali, K., Ghosh, S., Parua, P., Bandyopadhyay, B., Mondal, S.,Jana, M., Datta, A., Das, K., & Debnath, B. (2023). Natural dyes: Its Origin, Categories and Application on Textile Fabrics in brief. *Eur. Chem. Bull.* (issue 8),9780-9802

Ekeh, J. & Okoronkwo, S. (2016). Assessment of the Potentials of Dyes Extracted from Selected Plants on Cotton Fabric. *Social Science and Law Journal of Policy Review and Development*

Strategies. 5(1). 67-80.
Kiumarsi, A., Gashti, M. P., & Shamei, A. (2023). Application of natural dyes on textile fibers. *Coloration Technology*. 139(2), 89–102.
Lizamoni, C., Smita, B., & Ava, P. (2021). Natural Dyes: Extraction and Applications *International Journal of Current Microbiology and Applied Sciences.* ISSN: 2319-7706. 10(01). 1669-1677.
Nwoye, U. and Ezema P. (2017). Extraction and Utilization of Natural Dye Extract from Guinea Corn Leaf. *Journal of Development Strategies in Humanities, Management and Social Sciences.* ISSN Hard Print: 2360-9036 | ISSN Online: 2360-9044 | 7(1) 40-51.
Nwoye, U. and Ezema P. (2019). Assessment Ozzf Colour Fastness Properties Of Dye Extracted From Guinea Corn Leaves On Cotton Fabric. *Journal of Vocational Education,Training & Research.* 4.147-166.
Osabohien, P. (2014*).* Extraction and Application of Dyestuff from the Leaves of Guinea Corn and Onion Skin. *International Journal of Biological and Chemical Sciences.* 8(2). 811-820.
Ozougwu, S. & Anyakoha, E. (2016). Acceptability of cotton fabric treated with dye extracted from Roselle (Hibiscus sabdariffa) calyces based on its phytochemical composition and evaluation of organoleptic attributes. *African Journal of Agricultural Research*. 11(33). 3074-3081.
Ozougwu, U. & Anyakoha, U. (2013). Evaluation of the Organoleptic Attributes and Acceptability of Cotton Fabric Treated with Dyes Extracted from Beetroot (*Betavulgaris*) Indigenous Plant for Fabric Coloration*; Journasl of Home Economics Research.* 18(1). 261-263.
Salauddin, M, Mia R, Haque, A., & Shamim, M. (2021). Review on Extraction and Application of Natural Dyes. *Textile & Leather Review*. https://doi.org/10.31881/TLR.2021.09
Samanta, A. K., & Agarwal, P. (2022). Application of natural dyes on textiles*. Indian Journal of Fibre & Textile Research*. 47(3), 221–232.
Samanta, P. (2020). A Review on Application of Natural Dyes on Textile Fabrics and Its Revival Strategy. *Chemistry and*

Technology of Natural and Synthetic Dyes and Pigments DOI: http://dx.doi.org/10.5772/intechopen.90038. 1-24.

Shahid, M., & Mohammad, F. (2023). Recent advancements in natural dye applications. Journal of Natural Fibers, 20(1), 1–20.

Yakasai, S., Aliyu, A., & Isah, A. (2021). Dyeing of Cotton Fabric Using Roselle. *Nigerian Journal of Textiles (NJT*) Vol. 7: 78 – 81.

Yılmaz, F. & Bahtiyari, I. (2017). Investigation of the Usability of Hibiscus Plant as a Natural Dye Source: *International Symposium on Innovative Technologies in Engineering and Science*. 29-30.