EXTRACTION OF DYE FROM TWO PLANTS (*SORGHUM BICOLOR* AND *HIBISCUS SABDARIFFA*) AS A MEANS OF POVERTY ALLEVIATION AMONG RURAL WOMEN IN MORO LOCAL GOVERNMENT AREA OF KWARA STATE, NIGERIA

Received
January 05, 2025

Revised
February 14, 2025

Accepted
March 03, 2025

H. I. Uthman [1], M. A. Saad[1], I. O. Abdulquadir [2], * T. F. Olawepo[3]

[1] Department of Home Economics, Kwara State College of Education, Ilorin, Nigeria
[2] Department of Home Economics, University of Ilorin, Ilorin, Nigeria
[3]Department of Agricultural Science, Kwara State College of Education, Ilorin, Nigeria

Corresponding email: taiyeolwepo2012@gmail.com

Abstract: *Sorghum bicolor* and *Hibiscus sabdariffa* are common plants whose uses have not been fully utilized. However, the two plants are rich in anthocyanins which make them a good dye substrate. Therefore, this study assessed the extraction and acceptability of dyestuffs from *Sorghum bicolor* leaves and *Hibiscus sabdariffa* calyxes. Organoleptic Attributes Acceptability of Treated Fabric Evaluation (OAATFE) was used to evaluate the 5 coded samples treated with the dye extracts and the composites developed, which were SXB1, HYS4, ABS6, ASH8 and ABH3. Questionnaire was used to gather information on the acceptability and utilization of the two dye extract by women in five communities randomly selected in Moro local government area. The result of the findings revealed that characterization of *Sorghum bicolor* leaves and *Hibiscus sabdariffa* calyxes shows that different anthocyanins are the major colour bearing compound. All the samples are acceptable with fabric dyed, with dye extracted from *Hibiscus sabdariffa* calyxes is more acceptable. Additionally, in terms of organoleptic acceptability, there exist significant differences between the samples with *Hibiscus sabdariffa* calyxes having the highest acceptability. Thus, the study concludes that *Sorghum bicolor* leaves and *Hibiscus sabdariffa* calyxes are good sources of natural dyes as they are rich in colour yielding compounds (anthocyanin). Hence, dye extracts from *Sorghum bicolor* leaves and *Hibiscus sabdariffa* calyxes can be applied in dyeing cotton fabric. However the study recommends the use of extract of 100% *Hibiscus sabdariffa* for women in Moro local government area as a means of poverty alleviation.

Keywords: Dye extraction; Sorghum bicolor; Hibiscus sabdariffa; Application; Acceptability; Moro

1. INTRODUCTION

In the past, people have coloured food, clothing, and cosmetics with a variety of plant parts, including their roots, stems, barks, berries, leaves, and flower extracts [1]. W. H. Perkin synthesized dye in a lab in 1856, and as a result, there is now a difference between natural and synthetic dyes. Rapid advancements in synthetic dye research, development, and application cause a dramatic decline in the usage of natural colours [2]. Over the past few decades, scientists from all over the world have been driven to investigate new renewable bio-resource natural materials for colouring that would reduce the harmful environmental effects of using (azo and benzidine) synthetic dyes [3].

In most rural areas, many resources are underutilized particularly on the farm. Of such resources are left over from crop harvest as *Sorghum bicolor* and *Hibiscus sabdariffa*. For instance, the leaves of *Sorghum bicolor* constitute to major farm wastes while *Hibiscus sabdariffa* calyxes are underutilized. However, the anthocyanin pigments present in these plants can be applied in fabric dyeing. Also, the antioxidants' properties of anthocyanins found in *Hibiscus sabdariffa* and *Sorghum bicolor* makes them valuable food additives as they help prevent neural and cardio-vascular diseases, diabetes among others.

Sorghum bicolor belongs to the grass family, poaceae, and mainly grown for its grains while majority are not aware of its other uses. *Sorghum bicolor* leaves for instance are an excellent source of carbohydrate, protein, and minerals such as calcium, selenium, manganese, and iron. *Sorghum bicolor* is one of most widely cultivated crops in West Africa. In Nigeria for instance, it is locally called "Oka-baba", "dawa" and "okili" and mostly grown in the northern parts of the country. This is because it is genetically suited to hot and dry agroecology. Its production has significantly increased in the last four decades, from about 10 million metric tons to over 25 million metric tons [4]. *Sorghum bicolor* is used to produce colour for medication and porridge [5] and served as bioethanol as a source of energy [6]. Also, it serves as an important source of carbohydrate, protein, mineral such as calcium, iron and vitamin B complex [7].

Similarly, *Hibiscus sabdariffa* is a tetraploid that belongs to the plant family, Malvaceae, grown in Central and East Africa and East Asia. *Hibiscus sabdariffa* is useful as food beverage, gel as well as food colorant. *Hibiscus sabdariffa* locally known as isapa or zobo in Nigeria is widely grown in Central and West Africa. *Hibiscus sabdariffa* has been found to thrive on a wide range of soil conditions and its production has increased drastically across the regions. The plant contains high amount of iron content [8], rich in minerals especially potassium and vitamins such as ascorbic, acid among others [9].

Importantly, the two plants are rich in anthocyanin which makes them good sources of dye [10]. Dye is a coloured substance that has an affinity for the substrate to which it is applied. It is a chemical material used to impart colours to substrates as food, drugs, hair, textiles and polymers. Dyes can be obtained from natural and synthetic sources. Synthetic dyes are manufactured in industries while natural dyes are basically from plant (vegetable) animals as well as minerals [11] [12].

The extraction of nature dye from source can be done by a number of ways, such as solvent extraction, supercritical fluid, acid and alkali, drying and grinding. However, the two popular ways of extracting dye from *Sorghum bicolor* and *Hibiscus sabdariffa* are boiling and cold maceration methods. The boiling method involves boiling the plant part in water for a specified period of time. While the cold maceration method involving the use of a solvent, mixing the plant part with the solvent, leaving it for hours and then straining out the plant part [13] [14] [15] [16].

Studies have shown that synthetic dyes have negative effects on the environment and harmful to human health [12]. The use of natural dyes can reduce the hazard associated with synthetic dyes [16]. They do not contain harmful chemicals or toxins, which can cause allergic reactions or skin irritation so these dyes are often encourage to use in the textile industry to produce clothing, bedding, and other textiles that are hypoallergenic and safe for sensitive skin. [17] Many cultures have a rich history of using natural dyes to create traditional textiles and clothing. For example, in India, natural dyes have been used for centuries to produce beautiful and vibrant textiles. By preserving these traditions, we can ensure that our cultural heritage is passed down to future generations [18]. The production of natural dyes can provide income for small-scale farmers and communities. By cultivating flower crops that are used for natural dye extraction, farmers can diversify their income and create sustainable livelihoods [19].

Furthermore, different empirical studies have been conducted on extraction of dye from *Sorghum bicolor* and *Hibiscus sabdariffa*.

[20] carried out an experiment on extraction of natural dye from guinea corn, which was conducted in Chemistry laboratory in University of Uyo, Nigeria. The dye was produced in different states using distilled water and acetone plus sample in maceration and the yields were wine and slightly deep wine. While in soxhlet extraction, distilled water plus sample and acetone plus sample yielded slightly reddish brown and reddish brown. The extracted dyes yielded blush, deep blush, brick and deep brick respectively when applied on cotton fabric treated with alum.

Likewise, [21] conducted a study on the extraction dyestuffs from the leaves of guinea corn and onion skin. The *Sorghum bicolor bicolor* and *Allium cape* were collected chopped, dried and pulverized. The guinea corn leaves yielded dark red colour while onion skin gave brownish red colour. The extracted dyes were used to colour pap and illicit gin. The dyes were also used on fabric both mordanted and unmordanted.

However, debate on the application and acceptability of dyestuff extracted from *Sorghum bicolor* and hibiscus for fabric dyeing is still open. [22] reported poverty status at household level of Moro local government area as been 56% of the rural households are poor while 44% are not poor. He determinants the household poverty using logistic regression analysis and this reveals a significant predictor of the probability of being poor and per capita income ($p<0.05$) negative and a significant predictor of the probability of being poor.

Therefore, the objective of this study is to examine the extraction, application and acceptability of dye from *Sorghum bicolor* and *Hibiscus sabdariffa* in fabric dyeing to determine the best dye substrate for women of Moro local government area of Kwara State Nigeria. This will also be useful for the textile industries, create employment in the rural areas and reduce the hazard associated with the use of synthetic dyes.

2. MATERIALS AND METHODS

Materials and equipments used for the extraction of dye from this study were dried leaves of *Sorghum bicolor* and calyxes of *Hibiscus sabdariffa*, cotton fabric, alum, mortar and pestle, sieve, knife, spatula, weigh balance, measuring cylinder, funnel, and bowls. The extraction was carried out at the Department of Home Economics, Kwara State College of Education, Ilorin, Nigeria.

Dye extraction: Cold maceration was used for the extraction; the collected dried *Sorghum bicolor* leaves were chopped into smaller bits 100g of this was added to 500ml of methanol (absolute) and then left for three days. It was then filtered using a cotton

fabric and a filter funnel. The filtrate was kept airtight in a container. Also, a dried calyx of Hibiscus sabdariffa was milled and then 100g of this was added to 500ml of methanol (absolute) then left for three days. This was then filtered using a cotton fabric and a filter funnel. The filtrate was kept airtight in a container.

Characterization of the dye:

Determining the chemical component responsible for the pigment was carried out using HPLC analysis. HPLC machine of Agilent 110 Series was used for the analysis with a detector of Agilent. 1260.10µl of each sample was injected into the machine at dimension of 5 micrometer, 4.6*250mm at flow rate of 1.0ml/Min. The column used was YMC-Pack PROC18 Rs at column temperature of 30°C and a dimension of 5 micrometer, 4.6*250mm. The following solvents were used for the gradient elution: Solvent A; Water: Formic Acid (90:10) and Solvent B; Acetonitrile: Methanol: Water: Formic Acid (22.5:25.5:40:10). The analysis was run for the two extracts separately using the system specifications provided.

Development of Product:

Development of composite dyes: The dye extracts HYS4 and SXB1 were made into composite by mixing the samples in different volumetric proportions, thereby three composite sample of 75-25%, 25-75% and 50-50% were developed and two 100% of the extracts were also developed. Each of these samples measures 100ml.

Substrate Treatment: The fabric was cut into 24" by 14" which measures 25g. The cotton fabric was washed with warm soapy water so as to remove the fabric finishes applied on it, like wax and starch. This was to allow the fabric to be able to absorb the dye efficiently. Also, Mordanting: 5g of alum and 1gof table salt was dissolved in 500ml of boiling distilled water. Each of the fabric was mordanted for 2 hours after which they were removed.

Application of the dye extract: Contemporary plain dyeing method was adopted for the dye application. The dye bath was prepared with 112ml of the dye liquor in 500ml of distilled water for each of the samples. The fabric was then immersed in the dye bath, and heated to 80c for 15minutes, it was then left to cool for 5 hours after which the fabric was removed and dried in an airy shady place. This procedure was repeated for the remaining four samples and so five different dyed fabrics were developed. Colour properties of the dyed fabric were analyzed using colorimeter.

Data Collection: The instrument used for data collection was a questionnaire tagged Organoleptic Attributes Acceptability of Treated Fabric Evaluation (OAATFE) and evaluation session involved forty women from five communities namely Bode Saadu, Shao, Jebba, Oloru and lanwa the study local government area. The five dyed fabrics; HYS4 (100% *Hibiscus sabdariffa*), SXB1 (100% *Sorghum bicolor*), ASH8 (75% *Hibiscus sabdariffa* and 25% *Sorghum bicolor*), ABS6 (25% *Hibiscus sabdariffa* and 75% *Sorghum bicolor*), ABH3 (50% *Hiblscus sabdariffa* and 50% *Sorghum bicolor*) were blindly coded.

The scores for all organoleptic acceptability were recorded on the questionnaire. The data collected was analyzed using frequency, mean and standard deviation. The analysis of variance (ANOVA) was used to test the hypotheses at a 0.05 level of significance and means separated by Duncan Multiple Range Test.

3. RESULTS

The potentials of the extracted dyestuff from *Sorghum bicolor* and *Hibiscus sabdariffa* leaves in terms of organoleptic acceptability.

Table 1: Organoleptic Acceptability of the Samples

Sample Code	Colour	Texture (Sight)	Texture (Touch)	Odour	Evenness of Shade	Overall Acceptability
HYS4	3.80+.99[ab]	3.65+.82[a]	3.85+.84[a]	3.77+.79[a]	3.83+.89[a]	4.75+6.52[b]
SXB1	3.87+.91[a]	3.78+.69[a]	3.87+.77[ab]	3.70+.81[a]	3.67+.93[b]	3.97+.71[c]

Source: Field work (2023)

Key: HYS4; 100% *Hibiscus sabdariffa*

SXB1: 100% *Sorghum bicolor*

The Table 1 shows that the level of acceptability ranges between 3.0 and 4.0, which implies that all the sample are acceptable. SXB1 is the most acceptable in terms of colour with a mean value of 3.87, while HYS4is less acceptable with a mean value of 3.80. SXB1 is the most acceptable in terms of texture (sight) with a mean value of 3.78, while HYS4 is less acceptable with a mean value of 3.65. SXB1 is the most acceptable in terms of texture (texture) with a mean value of 3.87, while HYS4 is less acceptable with a mean value of 3.85. HYS4 is the most acceptable in terms of odour with a mean value of 3.77, while SXB1 is less acceptable with a mean value of 3.70. HYS4 is the most acceptable in terms of colour with a mean value of 3.83, while SXB1 is less acceptable with a mean value of 3.67.HYS4 is the most acceptable in terms of colour with a mean value of 4.75 while SXB1is less acceptable with a mean value of 3.97.

The acceptability of the organoleptic attributes of the fabric dye with extracted dye stuff from *Sorghum bicolor* and *Hibiscus sabdariffa* leaves.

Table 2: Acceptability of the Organoleptic Attributes of the Samples

Sample Code	Colour	Texture (Sight)	Texture (Touch)	Odour	Evenness of Shade	Overall Acceptability
HYS4	3.80+.99[a][b]	3.65+.82[a]	3.85+.84[a]	3.77+.79[a]	3.83+.89[a]	4.75+6.52[b]
SXBB1	3.87+.91[a]	3.78+.69[a]	3.87+.77[ab]	3.70+.81[a]	3.67+.93[b]	3.97+.71[c]
ASH8	3.43+.94[c]	3.65+.86[c]	3.83+.91[d]	3.50+.75[a]	3.23+.93[d]	3.65+.97[e]
ABH3	3.50+1.08[b]	3.83+.85[ab]	3.63+.82[c]	3.62+.83[b]	3.55+1.07[c]	3.80+.84[d]
ABS6	3.38+.90[d]	3.62+.78[a]	3.58+.87[e]	3.58+.77[a]	3.58+.91[e]	3.57+.87[f]

Source: Field work (2023)

Key: HYS4; 100% *Hibiscus sabdariffa*

SXB1: 100% *Sorghum bicolor*

ASH8; 75% *Hibiscus sabdariffa* and 25% *Sorghum bicolor*

ABH3; 50% *Hibiscus sabdariffa* and 50% *Sorghum bicolor*

ABS6; 25% *Hibiscus sabdariffa* and 75% *Sorghum bicolor*

The Table 2 shows the acceptability of such attributes as colour, texture (sight), texture (touch), odour, evenness of shade and overall acceptability. The level of acceptability however ranges between 3.0 and 4.0, which shows that all the sample are acceptable. However, sample SXB1 it the most acceptable in terms of colour with the mean value of 3.87 while sample ABH3 is the least acceptable with a mean value of 3.38. Sample ABH3 is the most acceptable in terms of texture (sight) with the mean value of 3.83 while sample ABS6 is the least acceptable with a mean value of 3.62. Sample SXB1 is the most acceptable in terms of texture (touch) with the mean value of 3.87 while sample ABS6 is the least acceptable with a mean value of 3.58. Sample HYS4 is the most acceptable in terms of odour with the mean value of 3.77 while sample ASH8 is the least acceptable with a mean value of 3.50.Sample HYS4 is the most acceptable in terms of evenness of shade with the mean value of 3.83 while sample ASH8 is the least acceptable with a mean valueof 3.23. Sample HYS4 is the most acceptable in terms of overall acceptability with the mean value of 4.75 while sample ABH3 is the least acceptable with a mean value of 3.577.

The difference in the potential of the fabric dyed with the dye extracts (*Sorghum bicolor* leave and *Hibiscus sabdariffa*) in terms of organoleptic acceptability

Table 3: Difference in the Potential of the Dye Extracts in terms of organoleptic acceptability

V	N	Sum of Squares	Df	Mean Square	F	Sig	Significance	Remark
Between groups		4246.967	12	353.914				
	60				18.816	0.000	Significant	Rejected
Within group		884.033	47	18.809				
Total		5131.000	59					

α = 0.05Source: Field work (2023)

Table 3 shows an F-value of 18.816 and a p-value of 0.000 less than the alpha level ($p<0.05$).This implies that there is significant difference in the potential of the fabric dyed with the dye extracts in terms of organoleptic acceptability.

4. DISCUSSION

Findings from the study revealed that both SXB1 and HYS4 are accepted, however, SXB1 is the most acceptable in terms of colour, texture (sight) and of texture (touch) while HYS4 is the most acceptable in terms of odour and evenness of shade. The majority of natural dyestuff and stains come from plants. They predominate as natural dye producers, yielding a variety of colours including red, yellow, blue, black, brown, and a mixture of these[23]. The majority of plant parts, including the roots, bark, leaves, fruits, timber, seeds, flowers, etc., create colours. It's interesting to note that, of the

nearly 2000 pigments that can be manufactured, only about 150 have been used commercially [2].

In overall acceptability, HYS4 is more accepted than SXB1. Also, the result showed that all samples are acceptable in terms of organoleptic attributes, however the level of acceptability differs. Additionally, finding of the study revealed that there is a significant difference in the potential of the fabric dyed with the dye extracts in terms of organoleptic acceptability. Natural flora and fauna offer a broad variety of exciting colours that give various synthetic and natural textile materials with harmonious, elegant, and austere shades [24]. Additionally, natural colorants impart a variety of functional finishing properties like insect repellent, deodorising, anti-feedants, antimicrobial, fluorescence and UV protective properties [3]. These properties have expanded the range of applications for natural colorants and contributed to their rising popularity in the creation of systematic, scientific, and diversified smart textile materials [25].

5. CONCLUSION

Based on the findings, the study concludes that *Sorghum bicolor* and *Hibiscus sabdariffa* are good sources of natural dyes as they are rich in colour yielding compounds (anthocyanin). Composite dyes were developed from these two plants and better hues could be made from them. Also, Sample HYS4 which was 100% *Hibiscus sabdariffa* gave the best substrate for dying of fabrics. Natural dyes extracted from flower crops can be explore for their potential use in medical textiles due to their non-toxic and hypoallergenic nature. Also it can be explore for it antimicrobial properties that can prevent the growth of bacteria on textiles. This makes them a promising alternative to synthetic antimicrobial agents, which can be harmful.

6. RECOMMENDATIONS

Based on the results of the study, the following recommendations are made;

i. It is recommended that awareness should be made on the use of natural dyes especially those of plant sources in textile dyeing.
ii. Dye extracts from *Sorghum bicolor* and *Hibiscus sabdariffa* should be used in dyeing cotton fabric in home dyeing and textile industries can adopt the use these plants.
iii. 100% *Hibiscus sabdariffa* can be applied in dyeing cotton fabric by women in Moro local government area of Kwara State, Nigeria as a mean of poverty alleviation.

7. ACKNOWLEDGMENT

This research is supported by Tertiary Education Trust Fund, Abuja.

References

[1] Gong, K., Rather, L. J., Zhou, Q., Wang, W., & Li, Q. (2020). Natural dyeing of merino wool fibers with Cinnamomum camphora leaves extract with mordants of biological origin: a greener approach of textile coloration. *The Journal of the Textile Institute*, 111(7), 1038-1046. http://dx.doi.org/10.1080/00405000.2019.1698228

[2] Nambela, L., Haule, L. V., & Mgani, Q. (2020). A review on source, chemistry, green synthesis and application of textile colorants. Journal of Cleaner Production, 246, 119036. https://doi.org/10.1016/j.jclepro.2019.119036

[3] Menegazzo, M. A. B., Giacomini, F., & Barros, M. A. S. D. D. (2020). Study of wool dyeing with natural dye extracted from chamomile flowers. *Journal of natural fibers*, 17(2), 271-283. http://dx.doi.org/10.1080/15440478.2018.1489333

[4] Adegbola, A., Awagu, E., Kamaldeen, O. & Kashetu, R., (2013). *Sorghum bicolor*: Most under-utilized grain of the semi-arid Africa. Scholarly *Journal of Agricultural Science*, 3(4). 147-153.

[5] De Alencar, F. F., Sine, B., Chantereau, J., Mestres, C., Flieded, G., Rami, F., Glaszmann, C., Deu, M., & Courtois, B. (2010). Variability of grain quality in *Sorghum bicolor*: Association with polymorphism in sh2, bt2 sss1, wx and o2. Theoretical and applied genetics. *International Journal of Plant Breeding Research*, 12(6), 1171-1185.

[6] Tanaka, L. (2006). Ethanol fermentation from biomass current state and prospects. *Journals Applied Microbiology and Biotechnolo*,. 69, 627-642.

[7] Oyetaye, L. & Ogunrotimi, I. (2016). Guinea corn *Sorghum bicolor* vulgere/leaf, a potential source of nutrients and photochemical. *Journal of Food and Public Health*, 2(6), 228-230.

[8] Margesei, S., Kagashe, G. & Dhokia, D. (2013). Determination of iron contents in *Hibiscus sabdariffa* calyxes and kigelia Africana fruit. *Scholarly Academic Journal of Biosciences*, 1(4), 108-111.

[9] Puro, K., Sunjukta, R., Samir, S., Ghatak, S., Shakuntala, I. & Sen, A. (2014). Medicinal uses of roselle plant (*Hibiscus sabdariffa*): A mini review. *Indian Journal of Hill Farming*, 27(1), 81-90.

[10] Ozongwu, 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; *Journals of Home Economics Research*. 18(1). 261-263.

[11] 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.

[12] Neha, G. & Vidya, P. (2011). Extraction and application of natural dye preparations from the floral parts of wood fondia fruticosa (Linn) Kurz. India. *Journal of Natural Products and Resources*, 2 (4), 403-408.

[13] Ragab, M. M., Hassabo, G.A. & Othman, A.H. (2022). An overview of natural dye extraction techniques for valuable

utilization on textile fabric. *Journal of Textile, Coloration and Polymer Science*, 19(2), 137-153. https://doi.org/10.21608/jtcps.2022.130253.1115

[14] Sayem, A. N. M., Ahmed, F., Saha, P. & Talukder, B. (2021). A review on natural dye: Raw material extraction process and their properties. *Advance research in Textile Engineering*, 6(1), 1062.

[16] Nwuzor, C.I., Adinoyi, J.B., Okey-Onyesolu, F.C. &Oyeoka, C.H. (2023). *Hibiscus sabdariffa* natural dye extraction process with central composite design for optimal extract yield. *SustainableChemistry for the Environment*, 2(24). https://doi.org/10.1016/j.scenv.2023.100008

[17] Menegazzo, M. A. B., Giacomini, F., & Barros, M. A. S. D. D. (2020). Study of wool dyeing with natural dye extracted from chamomile flowers. *Journal of natural fibers*, 17(2), 271-283. http://dx.doi.org/10.1080/15440478.2018.1489333

[18] Singh, P., & Sharma, A. (2021). Natural dyeing of cotton with hibiscus rosasinensis linn flowers for cosmetic applications. *Journal of Natural Fibers*, 18(3), 404414. https://doi.org/10.1080/15440478.2020.1792769

[19] Ghosh, S., Saha, S., & Bandyopadhyay, S. (2021). Natural dyes: An ecofriendly approach for textile dyeing. In S. Saha & S. Bandyopadhyay (Eds.), Handbook of Textile Coloration and Finishing (pp. 325-347). Woodhead Publishing. doi: 10.1016/B978-0-08-102726-7.00013-4

[20] Nwoye U. & Ezema, P. (2017). Extraction and utilization for natural dye extract from guinea corn leaf. *International Journal of Development Strategies in Humanities, Management and Social Sciences*, 7. 40-51.

[21] 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.

[22] Jatto, K. A. (2022) Determinants of rural poverty in Kwara State, Nigeria. *Journal of Agriculture Forestry and the Social Sciences*. https://www.researchgate.net/publication/364947543 DOI: 10.4314/joafss.v19i1.2

[23] Kulshreshtha, N., & Kumari, A. (2020). Natural dyes: An overview. In V. K. Gupta, A. Kumar, & M. B. G. Jun (Eds.), Green chemistry and sustainable technology: Perspectives and applications (pp. 311-331). Springer. https://doi.org/10.1007/978-3-030-46534-7_12

[24] Zayed, M., Bakr, M., & Ghazal, H. (2023). Recent developments in the utilization of polymer nanocomposites in textile applications. *Journal of Textiles, Coloration and Polymer Science*. http://dx.doi.org/10.21608/jtcps.2023.193744.1172 99.

[25] 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, 1-25. http://dx.doi.org/10.5772/intechopen.90038 100.