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FACTORS INFLUENCING THE USE OF NATURAL DYES: A CASE OF THREE SELECTED SECONDARY SCHOOLS IN SOLWEZI DISTRICT OF NORTH-WESTERN PROVINCE

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ABSTRACT

Many of us have our favorite colors and often prefer wearing clothes of that particular color. Though the colors that we are fascinated with over a long period of time are in one way or another connected to our personality type, our strengths and weaknesses, as well as our potential in life. But wearing your selective styles of garments in synthetic dyes and natural color dyes is a different experience altogether.

Color performance on textiles is affected by many factors. Pad dyeing of different cotton fabrics with vat dyes was carried out, and principal component analysis was used to analyze the comprehensive properties of fabrics. According to the factor weight, the main factors affecting the dyeing effect were obtained, and a mathematical regression model between the comprehensive values of fabric properties and the dyeing effect was established. The results

showed that with the increase of dye concentration, the apparent shade depth of the fabric increased correspondingly.

The purpose of this study was to determine or investigate the factors influencing the use of natural dyes in three selected secondary schools of Solwezi district. The main objective in this study was to investigate the factors influencing the use of natural dyes in selected secondary schools of Solwezi district. The study was confined within three (3) random sampled secondary schools in Solwezi district of North-Western province, in which a total of 60 teachers and learners were selected at random.

Keys words: *Factors, Influencing, Dyes, Dyeing, Natural, Perception, Use, and Textile.*

INTRODUCTION

This research involved the study of materials and methods of data collection, Literature Review, Results of the findings, Discussion of findings, Conclusion, and Recommendations.

Humanity has progressed from the Stone Age to the information age and is now making deep inroads into the environment age. This is characterized by increasing awareness regarding the effect of human interaction, both short and long term, with the environment. The extrapolated detrimental effect has evoked the need to conserve and protect our fragile environment. The growing public awareness has been expressed through an expanding premium market for goods and services that carry ‘natural’ or ‘eco-safe’ or ‘green’ or similar labels. Extensive research and development in science and technology are underway in order to satisfy this need. This provides an excellent focus point for the textile industry that deals with dye Tiwari, (2018).

Since prehistoric time natural dye is used for colouring of food, leather as well as fibres like wool, silk and cotton. The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes Jansen & Cardon, (2015).

Before 1856, the textile industry used only natural eco-dyes in the production of textile dyes. Therefore, in earlier times, the resources-to- resources model existed and were widely used. Under this model, we would use our natural resources, rather than chemicals, in the textile industry, thereby minimizing harm to natural resources, human health, and the environment.

Additionally, the waste generated through the use of natural resources can be safely returned to nature without harming nature (resources) itself. Tiwari, (2018).

Dyeing is an ancient art which predates written records. It was practised during the Bronze age in Europe. Primitive dyeing techniques included sticking plants to fabric or rubbing crushed pigments into cloth. The methods became more sophisticated with time and techniques using natural dyes from crushed fruits, berries and other plants, which were boiled into the fabric and gave light and water fastness (resistance), were developed Vankar, (2020).

According to Murumu, (2015), "natural dyes can be used on most types of material or fibre but the level of success in terms of fastness and clarity of colour varies considerably." In addition, users of natural dyes, however, tend to also use natural fibres, and so we will look in more detail at this group. Natural fibres come mainly from two distinct origins, animal origin or vegetable origin. Fibres from an animal origin include wool, silk, mohair and alpaca, as well as some others which are less well known. All animal fibres are based on proteins. Natural dyes have a strong affinity to fibres of animal origin, especially wool, silk and mohair and the results with these fibres are usually good. Fibres of plant origin include cotton, flax or linen, ramie, jute, hemp and many others. Plant fibres have cellulose as their basic ingredient.

Natural dyeing of certain plant based textiles can be less successful than their animal equivalent. Different mordanting techniques are called for with each category. When a blend of fibre of both animal and plant origin is being dyed, then a recipe should be chosen which will accentuate the fibre which is required to be dominant.

Colour has always played a dominant role in human life since time immemorial. In every civilization from Stone Age to the „Silicon slip age", it has played an important role in adding beauty to the world Bhuyan & Saikia, (2012). Our lives, the clothes we wear, the furnishings of our homes strongly influenced by colour Yusuf et al., (2017).

Dyes are the colourant matters which penetrate into the fibre and appear to become a part of it. Dyes may be either natural or synthetic and both these dyes are used for dyeing fibres, yarns and fabrics Singh & Srivastava, (2015). Presently there is a great demand for the use of natural colours throughout the world. All this happened due to the excessive use of synthetic dyes which is estimated around 700,000 tons per annum Gulrajani, (2016). Synthetic compounds are used for

dyeing textile materials and they cause water pollution as well as waste disposal problems because these are non-biodegradable and carcinogenic.

To get rid of this environmental as well as health hazards it is essential to think about alternative of synthetic dyes which can make safe environment and human health. To this view point natural dyes could be a good solution for textile sector. There are many natural dyes available in different plants and vegetables in the Universe which may be used as supplementary of synthetic dyes Guha, (2019). Another alternative which has fascinated many users is the use of natural dyes, i.e., those colourants which can be extracted out of vegetables or animal sources are in general considered to be eco-friendly in nature Singh & Srivastava, (2015).

Therefore, this study endeavored to investigate or determine the factors influencing the use of natural dyes in three (3) selected secondary schools in Solwezi District.

Research objectives

i. To investigate the factors influencing the use of natural dyes in three (3) selected secondary schools of Solwezi district.
ii. To examine teacher's and learner's perceptions on the application of natural dyes on fabric.

MATERIALS AND METHODS OF DATA COLLECTION

The researcher administered the instruments to teachers and learners in the three secondary schools through personal contact and with the help of two research assistants. The research assistants were given instructions on how to administer the questionnaire to teachers and learners at Solwezi Skills school, Solwezi day secondary school and Rodwel Mwepu secondary school. The copies of the questionnaire were collected back a week later by the researcher's assistants and the researcher herself, Cresswell, (2013).

The data collected was analyzed using descriptive statistics. Items from the questionnaires were arranged and grouped according to individual research questions. Responses received from the questionnaires was organized, tabulated and analyzed using frequencies and percentages and presented in form of frequency, Percentage, tables and figures on the computer software called SPSS (Statistical Package for Social Sciences), Denzin, (2015). Percentages have a considerable

advantage over more complex statistics. The information from the document analysis was analyzed qualitatively by sorting out data into various themes according to the objectives of the study. The information was discussed and this helped in drawing of conclusions and recommendations.

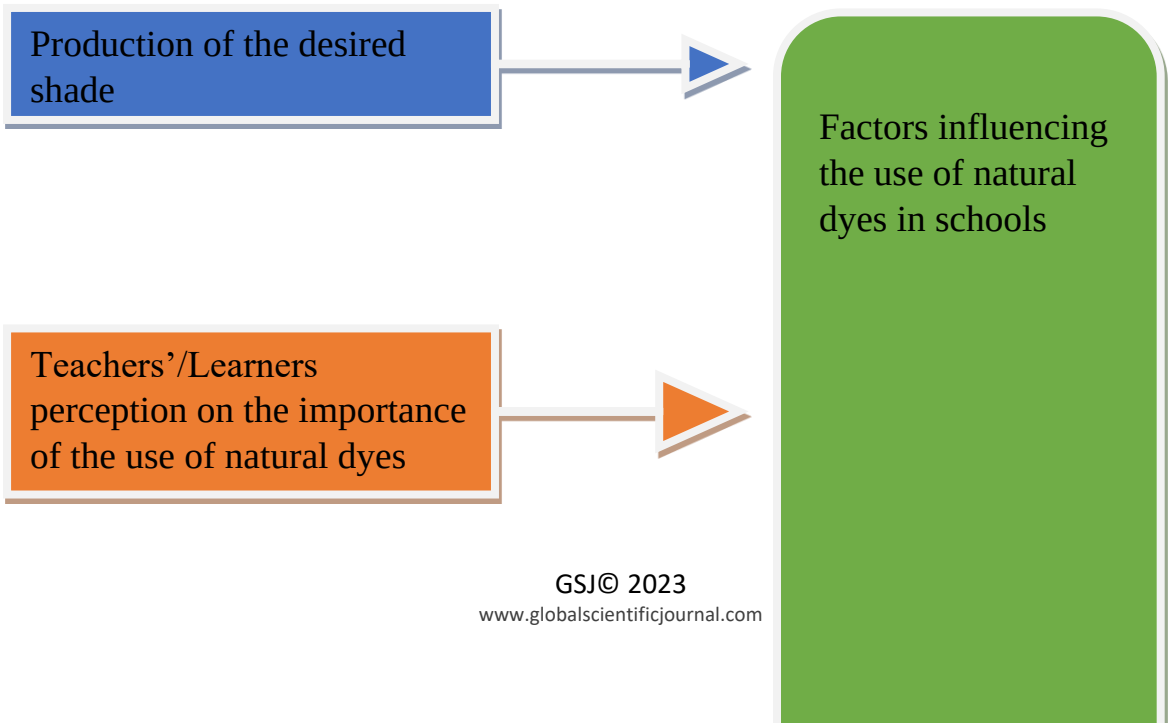
LITERATURE REVIEW

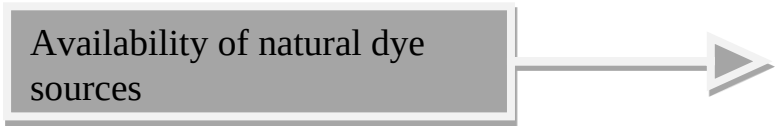
This chapter aims at providing knowledge of previous literature and theory relating factors influencing the use of natural dyes by teachers and learners in Solwezi district. Literature is reviewed as global, regional and local views.

2.1 Conceptual framework

According to Yaseen, (2019), "Textile wastewater requires dyes combined with a number of common pollutants. Environmental law also usually includes the handling of these effluents by the garment factories before discharge into the waters." Further, natural dyes extract from a variety of the substance that occur in nature such as plants you can get indigo and saffron while in insects you can get cochineal beetles and in animals some species of molluscs or shellfish); and minerals (e.g., ferrous sulphate, ochre, and clay) without any chemical treatment. The conceptual model developed for this thesis shows the steps necessary to be undertaken in order to develop a sustainable conceptual framework.

Figure 4. 1 Conceptual framework





Chilemu, 2023

Natural dyes: source of natural dyes

Natural dye can be obtained from different sources. Since ancient times natural dyes may have a wide range of shades and can be obtained from various parts of plants including roots, bark, leaves, flowers and fruit.

Dye is used as a sensitizer in dye sensitized solar cells which convert visible light into electricity using sensitization of the cell. Performances of these cells depend on dye. Sensitization is an important application of natural dye. Natural dyes are cutting down high cost of metal complex sensitizers and also replacing expensive chemical synthesis process through simple extraction process, Chengaiah, (2017)

In photo electrochemical water splitting titanium dioxide-based semiconductors are used. For promote the efficiency of photo electrochemical reaction natural dye sensitizers are used due to their environmental friendliness and low cost. Fast electron injection and slow backward reactions are exhibited by dye sensitizers. A protective layer like conductive polymer layer is required for natural dye sensitizer because it is unstable in solution, Gao, (2018).

Animal dyes

Natural dyes are biodegradable. They are non-toxic, non –allergic to skin non carcinogenic, easily available and renewable. Colour fastness is the resistance of a material to change any of its colour characteristic, is extent of transfer of its colorants to adjacent which materials in touch generally light fastness wash fastness and rub fastness are considered far textile fibres.

Insect Species

The lac insects fall under the Laccaferinae sub-family of the Lacciferidae, and of the various species the most important for commercial production is Lacciferlacca. In India, two strains are cultivated, "kusiumi" and "rangeeni", which differ in their seasonal cycle and preferred host trees. Strains in other lac producing countries are less well defined.

Few natural dyes are colour-fast with fibres. Mordants are substances which are used to fix a dye to the fibres. They also improve the take-up quality of the fabric and help improve colour and light-fastness. The term is derived from the Latin mordere, to bite. Some natural dyes, indigo for example, will fix without the aid of a mordant; these dyes are known as ‘substantive dyes’. Other dyes such as madder and weld have a limited fastness and the colour will fade with washing and exposure to light. Traditionally, mordants were found in nature, Daberao, (2016).

Wood ash or stale urine may have been used as an alkali mordant, and acids could be found in acidic fruits or rhubarb leaves (which contain oxalic acid), for example. Nowadays most natural dyers use chemical mordants such as alum, copper sulphate, iron or chrome (there are concerns, however about the toxic nature of chrome and some practitioners recommend that it is not used). Mordants are prepared in solution, often with the addition of an ‘assistant’ which improves the fixing of the mordant to the yarn or fibre. The most commonly used mordant is alum, which is usually used with cream of tartar as an additive or assistant.

Natural dyes of plant, mineral and animal sources are fascinating, beautiful and sometimes they challenge the wits of researchers and educators. Most of the dyes produce very colourful effects that are so amazing to behold. Natural colours are beautiful to behold Geelani, (2016). Colouring matter extracted from the roots, stems, leaves or barriers, and flowers of various plants have various exceptions and are also not substantive (have little or no colouring power by themselves) except when used in conjunction with mordants. Joseph, (2016) adds that the beautiful colours that are created from natural dyes would initially appear vivid, but soon fade. Lack of colour fastness resulted in the discovery of mordants - substances which aid in the absorption of dyes.

Until 1856, all textiles used throughout the world were natural dyes. That is, these dyes were obtained directly from the natural environment in one way or another. The vast majority of the natural dyes came from either plants or animals. For example, a major dye discovered by the

Aztec or Mayan Indians was ‘cochineal’. It is a relatively bright red that is obtained from the body of the cochineal insect. The insect must be crushed and the dye is refined from the remains of the insect. Reportedly, 70,000 insects are required to produce one pound of dye. Cochineal is still used today as a natural commercial product in both textile dyeing and in food coloring.

Plant dyes

The roots, nuts and flowers of plants that grow in our backyards are all sources of colouring pigments and dyes. The World Book Encyclopaedia (2010:212) notes that most natural dyes come from such parts of plants as the bark, berries, flowers, leaves, and roots while Shukla, (2017), mention the use of seeds, fruits, and young shoots as other sources of natural dyes. The outer, inner bark and heartwood of trees also produce dyes. Dyer points out the madder plant that grows in Asia and Europe as a source of bright red dye that is used on fabrics that include linen and silk. According to Gupta, (2014), the madder plant (Rubia tinctorum) was the source of a brilliant red permanent dye called “Turkey Red” or “Adrianople Red” which was very well known in 19th century domestic history for “maddering” wool and cotton.

The worldwide volume and variety of demand for colouring textiles is being met by a large range of synthetic dyes. Dye derived from natural materials such as plant leaves, roots, bark, insect secretions, and minerals were the only dyes available to mankind for the colouring of textiles until the discovery of the first synthetic dye in 1856. Rapid research strides in synthetic chemistry supported by the industrialization of textile production not only led to the development of synthetic alternatives to popular natural dyes but also to a number of synthetic dyes in various hues and colours that gradually pushed the natural dyes into oblivion,

However, environmental issues in the production and application of synthetic dyes once again revived consumer interest in natural dyes during the last decades of the twentieth century. In the earlier days, dyes were derived only from natural sources. But natural dyes suffer from certain inherent disadvantages of standardized application and the standardization of the dye itself as dyes collected from similar plants or natural sources are influenced and subjected to the vagaries of climate, soil, cultivation methods etc. Hence, for the natural dyes to be truly commercialized and to take a competitive place with respect to the synthetic dyes, the standardization methods play a very significant and vital role Geelani, (2015).

Since prehistoric time natural dyes is used for colouring of food substrate, leather as well as fibres like wool, silk and cotton. The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes. Indians have been considered as initiator in the art of natural dying. At present synthetic compounds are used for dying textile materials and they cause water pollution as well as waste disposal problems. These problems can be solved by the use of natural dye. There are huge applications of natural dye on textile so it is glamorous to promote technology for extraction.

Table 1 Categories of some natural dyes.

Natural dye classification		
Colours	**Chemical classifications**	**Common names**
Yellow and Brown	Flavone dye	Weld, Quercitron, Fustic, Osage, Chamomile, Tesu, Dolu, Marigold, Cutch
Yellow	Iso-quinoline dyes	Barberry
Orange-Yellow	Chromene dye	Kamala
Brown and Purple-	Naphthoquinone dyes	Henna, Walnut, Alkanet, Pitti
Red	Anthraquinone dye	Lac, Cochineal, Madder (Majithro)
Purple and Black	Benzophyrone	Logwood
Blue	Indigoid	Indigo
Neutral	Vegetable, Tannins, Gallotannins, ellagitannins, and catechol tannins	Wattle, Myrobalan, Pomegranate, Sumach, Chestnut, Eucalyptus

Source: Gao, 2018

The textile industry in general and textile colouration in particular are embracing the global ‘go-green’ movement. Sustainability is being promoted in all aspects of colouration. This is reflected

in consistent efforts towards obtaining desired results in terms of shade and fastness with a reduction in the quantity of consumables by optimizing the process. Another pathway being explored is reclaiming and reusing consumables from effluent. Substitution with consumables possessing a lower environmental impact is an attractive development. In the above instances, consumables include dyes, chemicals, auxiliaries, water, energy (usually heat) and at times even the textile substrate. These efforts have led to constant reports on zero-discharge processing. For example, Levi Strauss has gone further by encouraging recycling of denim and promoting efforts to reduce the amount of water required for washing during use Reid, (2016).

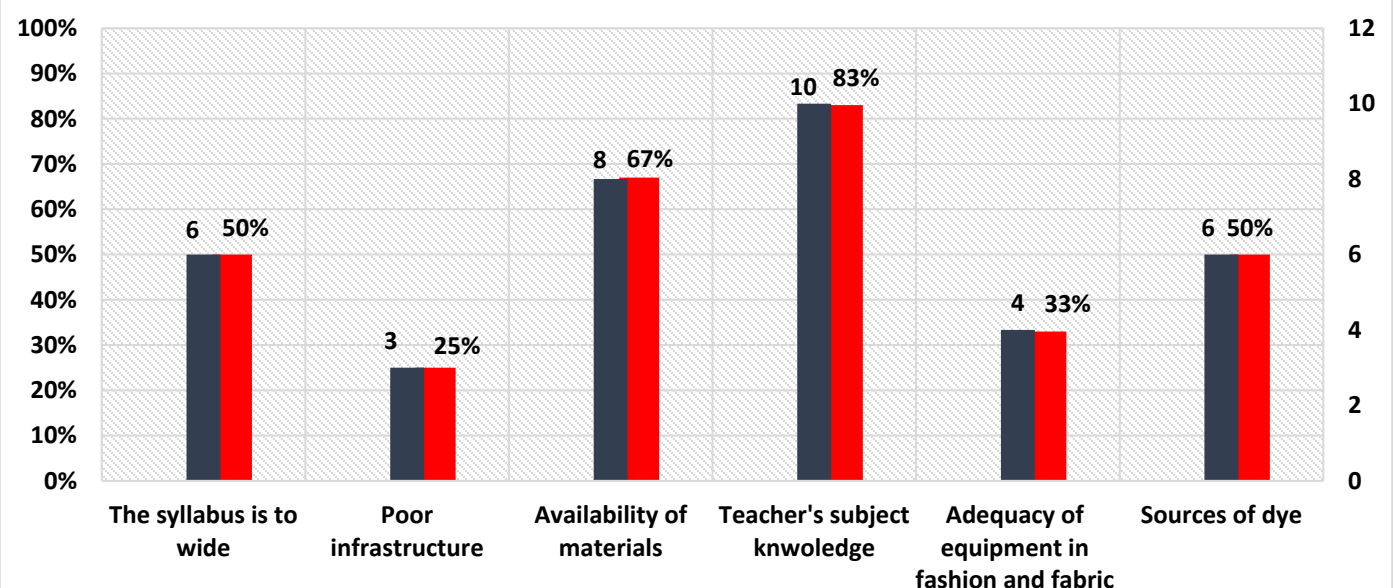
Natural dye can be obtained from different sources. Since ancient times natural dyes may have a wide range of shades and can be obtained from various part of plants including roots bark leaves to flowers and fruit. These dyes can be classified as 1) Natural dyes obtained from plants -Berry, flower, bark, leaf, seed and so on. ii. Natural dyes can be obtained from insects – Cochineal and lac. iii. Natural dyes obtained from animal – Mollusc, murex snail, cuttlefish and shellfish. iv. Natural dyes obtained from mineral – Clay, ochre and malachite. Natural dyes comprise those colorants (dye and pigments) that are obtained from animal and vegetable matter without chemical processing. Natural dyes fall into three categories on the basis of their origin: plant, animal and mineral.

RESULTS OF FINDINGS

DISCUSSION OF RESULTS

Factors influencing the use of natural dyes in selected secondary schools of Solwezi district.

Figure 2 Teachers' responses on Factors influencing the use of natural dyes in selected secondary schools of Solwezi district. n=12



The figure above shows teacher's responses on Factors influencing the use of natural dyes in selected secondary schools of Solwezi district. According to the findings, teacher's subject knowledge indicated by 83% of the respondents, availability of materials was indicated by 67% of

Source: Field data, 2023

The respondents, sources of dye as well as wide syllabus were indicated by 50% of the respondents each. Further, adequacy of equipment in fashion and fabric was indicated by 33% of the respondents while poor infrastructure was indicated by 25% of the respondents.

Table 2 Learners' responses on factors influencing the use of natural dyes in selected secondary schools of Solwezi district. n=48

SA=Strongly Agree, A=Agree, D=Disagree, SD=Strongly Disagree

Items	***S A*** f (%)	***A*** f (%)	***D*** f (%)	***S D*** f (%)	***Total***
				Infrastructure	
Poor infrastructure of the school	10 (21%)	20 (42%)	8 (16%)	10 (21%)	48 (100%)
Lack of laboratories	41 (85%)	0	7(15%)	0	48 (100%)
Lack of access to computers for research	48 (100%)	0	0	0	48 (100%)
				Management	
No provision of instructional material	0	10 (21%)	38 (79%)	0	48 (100%)
No enough desk to use when learning and studying	48 (100%)	0	0	0	48 (100%)
No field trips	0	32 (67%)	0	16(33%)	48 (100%)
				Funding	
Lack of equipment	38 (79%)	10 (21%)	0	0	48 (100%)
Lack of teaching and learning resources	0	41 (85%)	0	7(15%)	48 (100%)
				Human factors	

Number of teachers	0	0	48 (100%)	0	48 (100%)
Teachers' innovation and resourceful	0	7(15%)	41 (85%)	0	48 (100%)

Source: field data, 2023

From the findings above, no enough desk to use when learning and studying (100% SA) and lack of access to computers for research (100% A.S) were the most notable factors influencing the use of natural dyes in secondary schools of Solwezi district by learners. Others were lack of teaching and learning resources (85%), lack of laboratories (85%), lack of equipment (79%) and no field trips (67%).

Teachers'/learners' perceptions on the application of natural dyes on fabric

Table 3 Teachers' responses on perceptions on the application of natural dyes on fabric. n=12

Statement	**Agree**	**Disagree**	**Not sure**
They are environmental friendly	12 (100%)	0	0
They are biodegradable	12 (100%)	0	0
They are renewable	6 (50%)	0	6 (50%)
They are sustainable	3(25%)	3(25%)	6 (50%)
They are free from carcinogen	12 (100%)	0	0
They yield high profits	8 (67%)	0	4(33%)

Source: field data, 2023

From the table above, most teachers had a positive perception on the application of natural dyes on fabric as they were in support with the given statements.

Table 4 Learners' Responses on perceptions on the application of natural dyes on fabric. n=48

Statement	*Agree*	*Disagree*	*Not sure*
They are biodegradable	22 (46%)	4 (8%)	22 (46%)
They are environmental friendly	48(100%)	0	0
They are free from carcinogen	10 (9%)	0	38(91%)
They are sustainable	28 (58%)	3(6%)	17(36%)

They are renewable	22 (46%)	20(42%)	6(12%)
They yield high profits	38(91%)	0	10 (9%)

Source: field data, 2023

From the table above, learners had positive perceptions on the application of natural dyes on fabric as they were in support with the given statements.

CONCLUSION

The results of this study indicate the following:

(i) The respondents, sources of dye as well as wide syllabus were indicated by 50% of the respondents each. Further, adequacy of equipment in fashion and fabric was indicated by 33% of the respondents while poor infrastructure was indicated by 25% of the respondents.

(ii) From the findings above, no enough desk to use when learning and studying (100% SA) and lack of access to computers for research (100% A.S) were the most notable factors influencing the use of natural dyes in secondary schools of Solwezi district by learners. Others were lack of teaching and learning resources (85%), lack of laboratories (85%), lack of equipment (79%) and no field trips (67%).

(iii) Most teachers had a positive perception on the application of natural dyes on fabric as they were in support with the given statements.

(iv) Learners had positive perceptions on the application of natural dyes on fabric as they were in support with the given statements.

The aim of this study was to investigate the factors influencing the use of natural dyes in Solwezi district.

RECOMMENDATIONS

In the view of the various findings that emerged from this study, the following recommendations were made:

1. Sources of dyes as well as syllabus selection must be considered when choosing color for clothing and clothing characteristics influencing the use of natural dyes by both teachers and learners.
2. Clothing producers need to constantly carry out research on the needs of teachers and learners in order to improve the quality of clothes on the local market.
3. Teaching of Home Science and for that matter Textiles and Clothing be reintroduced and made compulsory at the basic level to equip children with knowledge and skills that will help them appreciate natural dyes in life.
4. The local clothing industry should put into consideration the perceptions of teachers and learners on what dyes to use in order to attract buyers / customers.

Recommendations for further research

1. Further research is hereby recommended with regard to the use of natural dyes.
2. Further research should also be done on Teacher Training Colleges.
3. Further research be carried out on the topic of this study in urban areas.
4. Further research be carried out on this topic using larger samples based on different cultural groups in Solwezi rural areas.
5. There is need to research into the perceptions of teachers and learners on the use of natural dyes in their day to day living.

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