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SPECTROPHOTOMETRIC AND INFRARED ANALYSES OF THE TOXICITY LEVELS IN THE SELECTED WATER COLOURS IN PRIMARY SCHOOLS

*[1]Adedeji Olumide Adeniyi, [2]Salisu Mohammed Aliyu, [3]Ogunleye Adepeju O.

[1]Department of Primary Education, Yusuf Maitama Sule Federal University of Education, Kano
[2]Department of Chemistry, Yusuf Maitama Sule Federal University of Education, Kano
[3]Department of Chemistry, Federal College of Education (Technical), Bichi, Kano

*Corresponding Author Email Address: ginshikijournal@gmail.com

ABSTRACT

Ultraviolet-visible and Infra-red spectroscopy of twelve (12) common water colours available in two primary schools in Gwale Local Government area of Kano state Nigeria were examined, the UV-Vis of the colours showed that the λ_{max} range between 726 nm and 408 nm and tend to shift to longer wavelength which according to literatures, associate increase in λ_{max} with increase in conjugation and molecular structure of an organic compound. Also, the Molar Extinction Coefficient of the colours range between 3.5 x 10^3 to 2.9 x 10^4, with water colours (WC) 12 having the highest value. The values obtained, although within the acceptable level ≥ 1 × 10^4 for most of the dyes, is low. Equally, the IR showed characteristic band in the range of 3428 - 3280 cm^{-1}, indicating the presence of O-H stretching vibration, 2937 – 2922 cm^{-1} shows =CH_2 with saturated C-H stretching. The C–N stretching occurred at 2126 – 2109 cm^{-1} while the carbonyl (C=O) stretching vibration appeared at 1689 – 1620. The azo (-N=N-) band occurred in the region of 1436 – 1420 cm^{-1} with stretching vibration of azo group. A strong band at 1006 – 991 $cm^{-1}$is due to the stretching vibration of S=O while the band at 879 – 864 $cm^{-1}$is due to the stretching vibration of C-Cl followed by C-Br group stretching vibration appearing at 790 - 745. The result depicts the characteristic azo chromophoric group, which, according to literature, can easily be reduced under mild reducing conditions, into forbidden aromatic amines such as benzidine, aniline and their derivatives. These compounds are toxic to the human body and are not eco-friendly. The implications of this and others for primary education were also examined. However, the UV-Vis and FT-IR spectroscopy of the water colours studied here did not reveal the chemical structure of the dyes; hence, there is a need to carry out GC-MS or NMR spectroscopy of the colours in order to determine their chemical structures.

Keywords: Water Colours, Ultraviolet-visible and Infra-red Spectroscopy, Functional groups and Molar Extinction Coefficient.

INTRODUCTION

Spectrophotometry is a technique used to measure how much a chemical substance absorbs light by measuring the intensity of light as a beam of light passes through a sample solution. The basic principle is that each compound absorbs or transmits light over a certain range of wavelength (Sharma *et al.,* 2021). Ultraviolet-visible spectroscopy is one of the simplest and economical methods of examining analyte interactions with radiation, where only the change in absorbance is measured as a function of wavelength. The technique is versatile and gives a rapid response regarding quantitative information (Cole and John 2017)
The term molar extinction coefficient (ε) is a measure of how strongly a chemical species or substance absorbs light of a particular wavelength (Chang *et al.,* 2018). It is an intrinsic property of chemical species that is dependent upon their chemical composition and structure. Thus, it's a fingerprint of a compound as it can be used to differentiate molecules and to define the range of wavelength where light has its maximum depth of penetration in materials, that is, a high extinction coefficient means a high absorption cross section (Lynta and Laura 2017).

The Fourier transform infrared (FT-IR) spectroscopy is an important physical technique among other techniques such as mass spectrometry, UV-visible and NMR spectroscopy. FT-IR spectroscopy is used to study the functional groups present in molecules and for the characterization of covalent bonds within the molecules (Yinon *et al.,* 2014). FT-IR spectroscopy is a non-destructive, fast and sensitive physical technique for the analysis of organic compounds with minimum sample preparation (Barcelo, 2010). It can serve as a fingerprint technique for the classification of unknown compounds; therefore, it is very helpful in classifying raw materials and ingredients that are used in dyes, paints, polymers, plastics, coatings, laminates, pharmaceuticals, foods and other consumer products (Rajaguru *et al.,* 2018). It is also useful for the structural elucidation and confirmation of known and novel natural organic compounds and products isolated from terrestrial plants and algae with the aid of other physical techniques such as mass spectrometry, UV-visible and NMR spectroscopy (Sharma *et al.,* 2021). FT-IR spectroscopy is also used in the analysis of fats and oils and it can also be associated with 'green analytical chemistry' because this technique reduces the use of chemical reagents hazardous to the environment and human health (Cole and John 2017 Nowadays, new environmental issues are emerging and there are more concerns on the ecological use of safe and environment friendly chemicals in consumer goods and products.

Dyes may be defined as coloured substances, which are capable of application in aqueous solution or dispersion to a substrate, so that the substrate acquires a colour appearance (Bello *et al.,* 2018). Generally, all colours may be classified as animal, vegetable, mineral, synthetic or abstract. Animal and vegetable colouring matter are organic substances,, they are complex chemical materials containing carbon, hydrogen, and usually oxygen or nitrogen derived from the roots, seeds, fruits, leaves, and barks of plants. While animal dyes usually come from worms and shells (O

Neil *et al.,* 2019). However, mineral or "abstract" colours are usually permanent, examples include those of rocks, glasses, ceramics, enamels and jewels. Purely physical effects of refraction and dispersion of light produce abstract colours; no actual coloured substance is present. Examples are brilliant blue, green and violet of many insect wings, bird feathers and some mineral colours, as in opals (Rajaguru *et al.,* 2018).

Water colour dyes were invented in China and did not arrive in Europe until the 13th century but they soon became popular. Old watercolour recipes used to contain honey as it made the paint soft. By the 18th synthetic water colours made of hydrocarbon organic compounds (dyes) had been widely circulated around the world (Torres *et al.,* 2018). It became a pack of resources for primary school introductory lessons, to even a core subject (Creative Arts). Also, to challenge pupils or students to get creative with a wide range of simple and complex tasks, which include PowerPoint, worksheet and teaching Ideas resource, water colour pack, and become teachers' delight (Chang et al., 2018).

Water colours are water or alcohol soluble dyes commonly used in pre-primary, primary and junior secondary schools for drawing, writing and painting. There are many different types currently in use in primary schools and the most common are the tubes, tray, and bottles filled with liquid pigment. In addition, they can be purchased in the form of pencils, markers, and sheets (Lynta and Laura 2017).

Watercolour pans come in small containers that are also called *cakes*. They can be bought in half pans and full pans. The great thing about the pans is that they are small, compact, and portable. The pigment is durable, which makes it a great long-term investment. One of the downsides of painting with pan pigment is that they do not dry as vibrantly as tube pigment (Patel *et al*., 2019).

Watercolour bottles are bottles filled with very concentrated pigment in liquid form. One of the best benefits of watercolour bottles are their intense vibrancy; for this reason, many people love creating colourful artwork with these liquid pigments. However, one of the disadvantages of watercolour bottles is that they do not have the best light fastness properties (Chang *et al*., 2018 and Patel *et al*., 2019).

Watercolour pencils are very unique because they combine the best qualities of watercolour painting and drawing. These watercolours are shaped like pencils but contain water-soluble pigment, which means you can use them in both a dry and wet format. Simply lay down pigment as if you were using coloured pencils, or, activate the pigment with a damp paint brush to create beautiful, loose water colour effects. Also, you do not need a lot of water to activate these pigments and due to their portable nature, these pencils are very convenient when painting outside the classroom. It should be noted that water colour pencils, like pans, will dry less vibrantly than tube paint or liquid water colours (Chang *et al*., 2018 and Patel *et al*., 2019).

Watercolour markers are shaped just like regular markers, but what sets them apart is that they contain water-soluble ink. This pigment can be applied both in dry format or water can be added to dilute the pigment and create loose painterly effects. As well, the brush tips glide smoothly over the paper in a way that mimics a paintbrush to give each brush stroke a painterly look. The tips, which are usually made of nylon, are pliable and make them great for user who desires the versatility to easily switch between drawing and painting. But, similar to water colour pencils, these markers don't necessarily have the strong vibrancy or the long-lasting light fastness (Masayoshi and Nakabara 2021).

Watercolour sheets are exactly as they sound, the booklet contains sheets of paper that have dry watercolour pigment on them. The advantage of painting with watercolour sheets is that they are lightweight and portable (Chang *et al*., 2018 and Patel *et al*., 2019).

In water colours, the chemical structures of the dyes present are not disclosed due to commercial reasons. As a result and in view of the environmental and health issues of colouring materials, the researchers envisages the possibilities of identifying functional groups that could be of great concern in the following; flora and fauna of the ecosystem, health concern to humans, biodegradability and long term effect of constant use of water colours in twelve dyes of a water colour pans readily available and in use in selected primary schools, Gwale Local Government area of Kano State.

Experimental

Water colours containing dyes are standardized products for specific end-use and are not homogeneous chemical compounds. They often have impurities and may contain a large amount of shading components, most of which can seriously interfere with the UY-Vis and IR spectra analyses. Therefore, separation and purification are necessary to obtain the pure state of dyes for accurate analysis (Patel *et al*., 2019).

There are many different types of water colours; however, twelve (12) commonly available was used for this research. 50 cm³ of each of the dyes was first dehydrated in an oven at 40 °C for 120 hours. After dehydration, 50 cm³ of acetone was added to the dye sample and the impurities were filtered with the use of filter paper and a funnel. Finally, the mixture of acetone and pure dye (filtrate) was put in an oven at 40 °C for 40 hours to completely evaporate all of the organic solvent (Yuen *et al*., 2020). The entire water colour sample was treated in this way for the analysis.

The spectrophotometric properties of the water colour dyes (WC 1 – 12) were examined using the procedure given by Navarro and Sanz (2019). The sample concentrations were adjusted so that the absorption intensities of the components were roughly the same. The water colours sample solutions were prepared and each solution was then scanned from 400-800 nm by the Spectrum Version UV-visible spectrophotometer at Agilent Technologies, Zaria

The IR spectral was obtained by the potassium bromide (KBr) pellet preparation technique, which is a simple and common method to prepare a sample ready for IR analysis. A spectral grade of KBr was used, and its powder was dried in an oven at 80 °C for 24 hours to completely remove the moisture before preparing the sample pellet. The entire dried water colour samples prepared from the purification processes were immediately used to prepare the KBr sample pellet. The KBr sample pellet containing approximately 500 μg to l mg of the dry water colour samples was mixed with the dry KBr powder in a ratio 1: 100. The mixture was then be milled with a small agate mortar until the dried ink powder was completely mixed with the KBr powder. After milling, the mixture was immediately compressed under hydraulic pressure for about 5 to 6 minutes, and the thickness of the KBr sample pellet was controlled to 1 mm to 2 mm. A KBr sample pellet was formed and ready for FTIR spectra analysis (Patel *et al*., 2019 and Yinon *et al*., 2020).

An Elmer System Range 4000 - 650 FT-IR Spectrometer was be used to obtain the IR spectrum of the water colour samples. Before measuring the sample, the background of the FT-IR will be scanned with the following scanning conditions: a resolution of

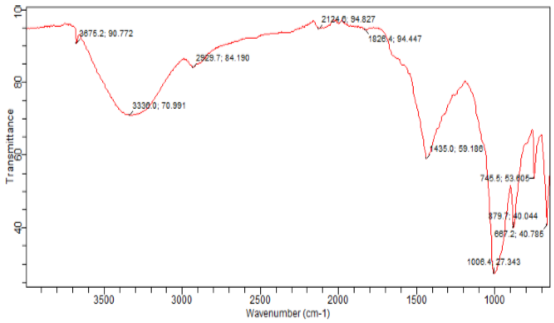
1cm-' and 16 scans. This process is crucial for eliminating the effect of background absorption. The KBr sample pellet was then re-scanned twice. After scanning, the spectra of the samples were generated and the major peaks were labeled with the help of a computer software installed in the FT-IR spectrometer (Patel *et al*., 2019 and Yinon *et al*., 2019).

RESULTS AND DISCUSSION

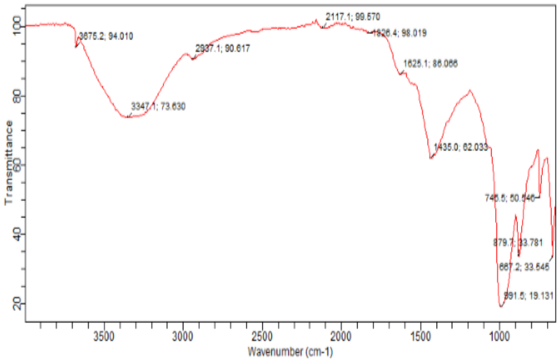
The results of the UV-VIS spectroscopy of the water colours is presented in Table 1, showing the colour and the spectroscopic properties of the dyes (WC 1 – 12). Also, the results of the FT-IR spectroscopy of the water colours are presented in Figures 1 – 12 and Table 2.

Table 1: UV-VIS Spectroscopic Properties of Water Colours

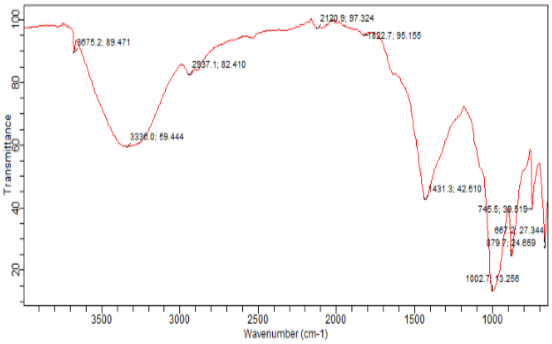
Colour Water		Wavelength (nm)	Conc g dm^{-3}	Absorbance	Molar Extinction Coefficient
WC 1	White	449	1.2 x 10^{-4}	2.367	1.9 x 10^{4}
WC 2	Orange	424	1.2 x 10^{-4}	1.040	8.6 x 10^{3}
WC 3	Red	550	1.2 x 10^{-4}	0.420	3.5 x 10^{3}
WC 4	Dark blue	726	1.2 x 10^{-4}	3.029	2.5 x 10^{4}
WC 5	Purple	569	5.0 x 10^{-5}	1.065	2.1 x 10^{4}
WC 6	Light green	435	1.2 x 10^{-4}	2.454	2.0 x 10^{4}
WC 7	Brown	765	3.2 x 10^{-5}	0.900	2.8 x 10^{4}
WC 8	Dark green	644	3.0 x 10^{-5}	0.670	2.2 x 10^{4}
WC 9	Yellow	438	1.2 x 10^{-4}	1.207	1.0 x 10^{4}
WC 10	Pink	534	1.2 x 10^{-4}	2.499	2.0 x 10^{4}
WC 11	Light blue	616	7.5 x 10^{-5}	1.624	2.1 x 10^{4}
WC 12	Black	408	1.2 x 10^{-4}	3.510	2.9 x 10^{4}



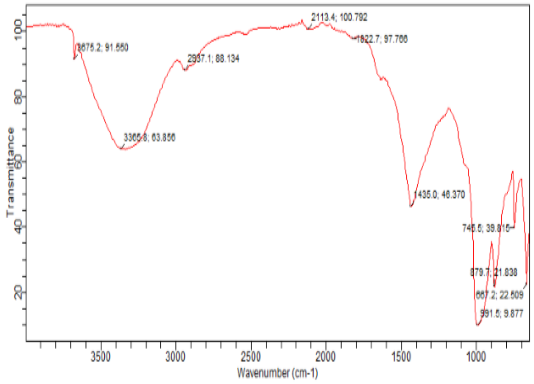
Figures 1: Water colour 1



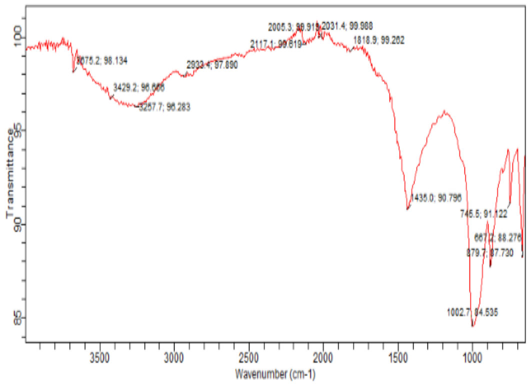
Figures 2: Water colour 2



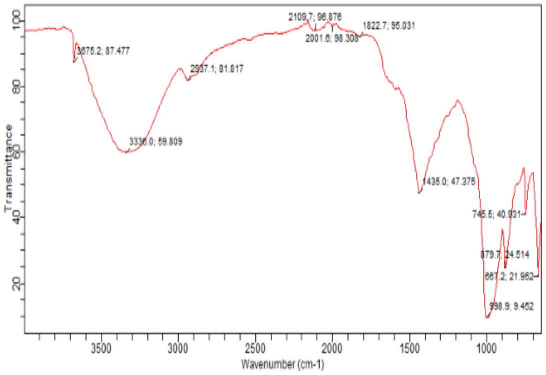
Figures 3: Water colour 3



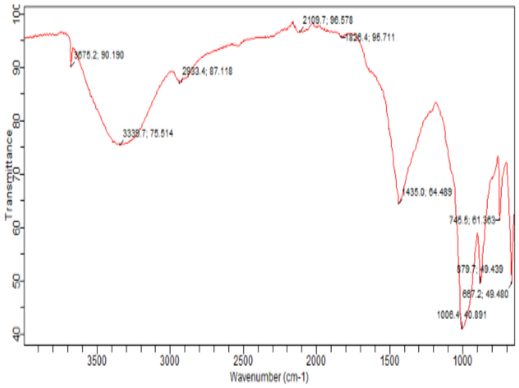
Figures 4: Water colour 4



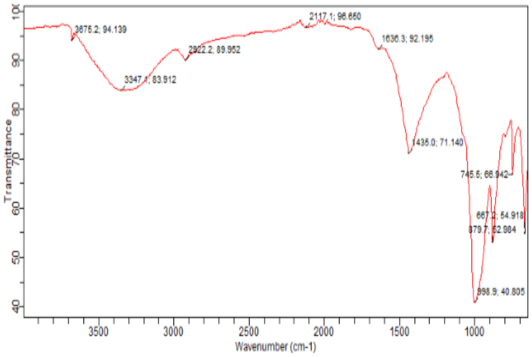
Figures 5: Water colour 5



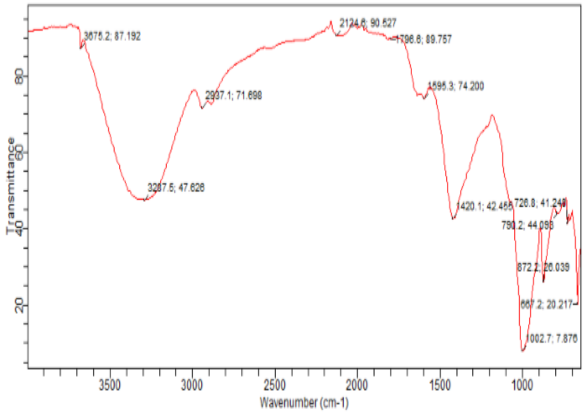
Figures 6: Water colour 6



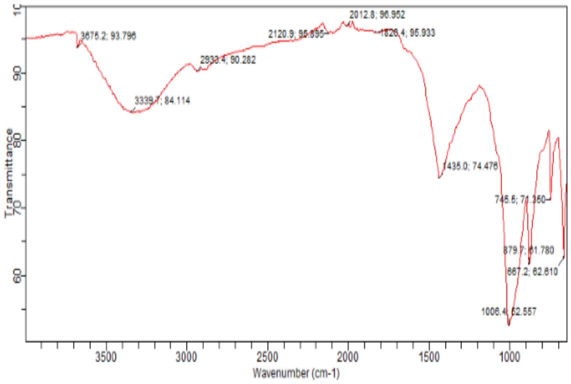
Figures 7: Water colour 7



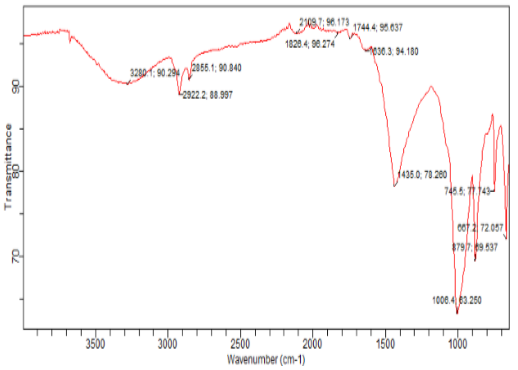
Figures 8: Water colour 8



Figures 9: Water colour 9



Figures 10: Water colour 10



Figures 11: Water colour 11 Figures 12: Water colour 12

Table 2: FT-IR of Water Colours (WC 1 - 12).

Dyes	IR (cm^{-1})
WC 1	3332 (-OH), 2937 (=CH$_2$), 2117 (C-N), 1643 (-C=O), 1435 (-N=N-), 1003 (-S=O), 879 (C-Cl), 745 (C-Br)
WC 2	3336 (-OH), 2929 (=CH$_2$), 2126 (C-N), 1620 (-C=O), 1435 (-N=N-), 1006 (-S=O), 879 (C-Cl) 745 (C-Br)
WC 3	3336 (-OH), 2937 (=CH$_2$), 2117 (C-N), 1652 (-C=O), 1435 (-N=N-) 1003 (-S=O) 864 (C-Cl), 745 (C-Br)
WC 4	3336 (-OH), 2937 (=CH$_2$) 1822, (C-N) 1651, (-C=O), 1431 (-N=N-) 1002, (-S=O), 879 (C-Cl), 745 (C-Br)
WC 5	3365 (-OH), 2937 (=CH$_2$), 2113 (C-N), 1651 (-C=O), 1435 (-N=N-) 991(-S=O), 879 C-Cl), 746 (C-Br)
WC 6	3428-3257 (-OH and -NH), 2932 (=CH$_2$), 2117 (C-N), 1651 (-C=O), 1435 (-N=N-), 1003 (-S=O), 879 (C-Cl), 745 (C-Br)
WC 7	3336 (-OH), 2937 (=CH$_2$), 2109 (C-N), 1643 (-C=O), 1436 (-N=N-), 998 (-S=O), 879 (C-Cl) 745 (C-Br)
WC 8	3339 (-OH), 2933 (=CH$_2$), 2109 (C-N), 1635 (-C=O), 1435 (-N=N-), 1006 (-S=O), 879 (C-Cl), 745 (C-Br)
WC 9	3338 (-OH), 2932 (=CH$_2$), 2117, (C-N), 1643 (-C=O), 1435 (-N=N-), 998 (-S=O), 879 (C-Cl), 745 (C-Br)
WC 10	3347 (-OH), 2922 (=CH$_2$), 2126, (C-N), 1651 (-C=O), 1420 (-N=N-), 1002 (-S=O), 872 (C-Cl), 790 (C-Br)
WC 11	3280 (-OH), 2922 (=CH$_2$), 2120, (C-N), 1643 (-C=O), 1436 (-N=N-), 1006 (-S=O), 879 (C-Cl), 745 (C-Br)
WC 12	3287 (-OH), 2937 (=CH$_2$), 2109, (C-N), 1689 (-C=O), 1435 (-N=N-), 1006 (-S=O), 879 (C-Cl), 745 (C-Br)

Table 1 gives the peak wavelengths, concentration, absorbance and the molar extinction coefficients of various water colours. The result showed that the λ_{max} range between 726 nm and 408 nm also it tend to shift to longer wavelength (Bathochromic shift). This probably due to increase in conjugation in the molecular structure of the water colours samples equally the action of auxochromes might amplify the absorption intensity observed in samples white and black. The result is in agreement with the works of Patel *et al.*, 2019, Jooneck *et al.,* 2017, Yinon *et al.,* 2019 and Colthup *et al.*, 2021 which stated that with larger conjugated systems, the absorption peak wavelengths tend to be shifted toward the long wavelength region and the absorption peaks tend to be larger.

Water colours are dyes which tend to have large conjugated systems, these conjugated systems have a large influence on peak wavelengths and absorption intensities, and therefore in Table 1, their peak wavelengths tend to be shifted toward the long wavelength region, with peaks appearing in the visible region (400 to 700 nm). This is why they are recognized as colours. Incidentally, the colour that we see is the colour that is not absorbed by the substance (which is called the complementary colour) (Potera, 2020).

According to Masayoshi and Nakabara (2021), absorption in the ultraviolet and visible regions is related to the transition of electrons. Transition refers to the switching of an electron from one state of motion to another. The state of motion of the π electrons in the conjugated system changes more easily than that of the σ electrons that form the molecular frameworks. If a photon collides with a π electron, that π electron readily changes to a different state of motion. This is true even if the photon has only a small amount of energy. The π electrons in relatively large conjugated systems are more easily affected by low-energy photons. Transition expresses the way that the energy of photons is absorbed by electrons. If a photon has a relatively small amount of energy, the value of hc / λ (h is Planck constsant, c Velocity of light and λ Wavelength) for that photon is relatively small, and therefore the value of λ relatively large λ is observed as the absorption wavelength and so, if there is a conjugated system, peaks tend to appear in regions where λ is large, that is, the long wavelength region (Color Additive Status List 2017).

Molar Extinction Coefficient

Table 1gives the molar extinction coefficient of the colours, which range from 3.5 x 10^3 to 2.9 x 10^4 with WC 12 having the highest value, while WC 3 has the lowest. According to Patel *et al.*, (2019), for commercial colouring material, the molar extinction coefficient should be greater than or equal to 10000 (≥ 1 × 10^4) for it to be accepted as a colouring material that can be fixed on a substrate. In Table 1 WC 1,4,5,6,7,8,9,10,11, and 12 are within the acceptable range, while WC 2 and 3 values fell short of the required level.

The molar extinction coefficient is a measurement of how strongly a substance absorbs light and its ability to stain or be absorbed onto a substrate, which may be cellulosic, concrete, plastic and so on. It is known that extinction coefficient values do not vary much from solvent to solvent, unlike the wavelength. The larger its value, the greater the absorption and its affinity for the substrate, equally for a substance to act as a colouring material certain constitutional conditions must be met, namely; It must have a suitable colour, must be able to fix itself or capable of being fixed to the substrate and when fixed, it must be fast to light, washing perspiration, rubbing, gas fumes and other agencies likely to cause dissolution from the substrate dye degradation (Anguilar *et al.,* 2012). Molar extinction coefficient of water colours under investigation is indicative of the amount of colour that would be fixed on the substrate when used in the classrooms., however the values obtained seem to be lower when compared with other known dyes whivh are used for dyeing fabrics, this probably because water colours are not required to be fixed permanently to the substrate and when used on the substrate, it is required to be easily wiped off easily without staining the substrate in most cases.

FT-IR Analysis

The infrared results as presented in Table 2, depict the characteristics of azo dyes showing peaks corresponding to the functional groups present in the water colours. The spectra of all the colours showed the characteristic band in the range of 3428 - 3280 cm$^{-1,}$ indicating the presence of O-H stretching vibration, 2937 – 2922 cm^{-1} shows =CH$_2$ with saturated C-H stretching. The C–N stretching occurs at 2126 – 2109 cm^{-1} while the carbonyl (C=O) stretching vibration appears at 1689 – 1620. The azo (-N=N-) band occurred in the region of 1436 – 1420 cm$^{-1,}$ which is a stretching vibration of the azo group. A strong band at 1006 – 991 cm^{-1}is due to the stretching vibration of S=O , while the band at 879 – 864 cm^{-1}is due to the stretching vibration of C-Cl followed by C-Br group stretching vibration appearing at 790 - 745.

The IR values obtained are in agreement with the functional groups reported by Majeed *et al,* (2011) and Adeniyi *et al.* (2024) in their research, the preparation, characterization and the study of the linear optical properties of a new azo compound and the synthesis and characterization of reactive dyes based on 2-phenyl-3-(3,4 aminophenylsulphomido)-quinazolinone-6-sulphonic acid respectively reported characteristic band in the range 3630 - 3510 cm^{-1} indicating the presence of OH and NH stretching vibration in addition to absorption band at 1655 cm^{-1} is due to (-C=O) of the quinazoline molecule. The band at 1430 cm^{-1} is due to the stretching vibration of the azo (-N=N-) group. A strong band at 1380 cm^{-3} is due to the stretching vibration of the (-C-N) group, bending vibration, and the band at 1320 – 1166 cm^{-1} is due to the stretching vibration of -S=O group. While the band at 762 cm^{-1} is due to the bending vibration of the C–Cl stretching vibration.

Functional Groups Present in the Water Colours

The analysis showed that the twelve (12) water colours have azo (-N=N-) chromophoric group appearing at 1436 – 1420 cm^{-1}, also present are the following auxochromes: hydroxyl (-OH), carbonyl (-C=O), sulphonyl (-S=O), chloro (-Cl) and bromo (-Br). From this, it can be said that the water colours are azo dyes and by comparing the IR spectra from the twelve colours, it was observed that the IR absorption frequencies of WC 1, 2, 3, 4, 5, 7, 8, 9, 10 and 12 were very similar. This revealed that they might possess similar or the same functional groups and chemical compounds. However, this did not mean that they possessed the same structure. The number, arrangement and combination of the functional groups and compounds could vary, so that different chromophoric groupings are present in their structure. The spectra of WC 6 and 11 are equally similar, indicating similar functional groups and chemical compounds except for the aliphatic =C-H vibration being more pronounced in WC 11. The IR spectra of all the water colours at 1500 cm^{-1} and above are all similar. Also worth noting is the solubilizing effects of the hydroxyl, carboxylic and sulphonic groups, as they all contribute to the water colours high solubility in water. The hydroxyl (–OH), primary and secondary amine (–NH_2 and =N-H) often exist in dye structures, the absorption band of the N-H stretching may sometimes be confused with O-H. The N-H absorption is usually sharper as in WC 6

Implication for Primary Education

The water colours studied here are those commonly used in our pre-primary and primary schools. The implication of this in education is that since these categories of pupils are in their early developmental levels, a stage at which they are bound to their physical environment. Equally, most of their activities involve trial and error, and constant practice becomes the order of the day. Also, pupils are not required to produce more permanent and long-term works, therefore water colours are perfectly suited to this stage of development as the dye in these colours are not that substantive.

Furthermore, to avoid pupils painting their bodies and school uniforms with more substantive dyes, water colours become a close call. Pupils are also fascinated by the bright colours of the dyes in water colours as it arrest and sustain their attention. Equally, for rough work, class display, decoration, instructional materials, painting and so on, water colours have become a sight to behold in early schooling.

Azo colourant encompasses azo (-N=N-) linkage in their chemical structure and are therefore capable of colouring diverse substances by selective reflection or by transmission of daylight. It ranges in shade from greenish yellow to orange, red and brown (McLean and Freas 2017). The colours depend largely on the physical properties. The part of the azo colourant molecule which produces colour, the chromophoric group, is a double-bonded azo linkage, which alters the colour of a substrate, either by selective absorption or by scattering of visible light (Navarro and Sanz, 2019). This is indicative of why water colours are widely used at the elementary school level as their brilliant colours attract and sustain attention of children at the pre-primary and primary school levels.

However, according to Patel *et al.* (2019), azo chromophoric groups, especially, can easily be reduced under mild reducing conditions (sometimes even with the help of some enzymes in the human body), splitting them into forbidden aromatic amines such as benzidine, aniline and their derivatives. Thus, releasing toxic chemicals into the human body and environment, although standard methods are available and have been adopted globally to determine these harmful aromatic amines and ways to ameliorate their effects in many of consumer products. The drawback in such methods is the use of chemical reagents, which sometimes are hazardous to human health and the environment (Cole and John 2017). Also, serious studies according to O Neil *et al.,* 2018, are ongoing in relation to azo dyes for their safety to humans and the environment. Developments are fluid efforts are concentrated at eliminating these forbidden aromatic amines in the synthesis of colourants for food, make-up and other consumables.

Teachers and caregivers should take important notice of their pupils and guide them properly to use water colours appropriately, and any cases of injection by pupils should be reported to the nearest health centre. In cases where pupils paint their bodies with water colours, running water should be used to clean affected body parts thoroughly. Parent should also examine their ward after school activities, especially the mouth and tongue for any unusual colour and report to the nearest medical centre.

Conclusion

The UV-Vis and infrared spectroscopy of twelve (12) commonly available water colours in use in primary schools were examined. The UV-Vis result showed WC 1,4,5,6,7,8,9,10,11, and 12 are within the acceptable range, while WC 2 and 3 values fell short of the required level. Also, the IR showed a characteristic band in the range of 3428 - 3280 cm$^{-1,}$ indicating the presence of O-H stretching vibration, 2937 – 2922 cm^{-1} shows =CH_2 with saturated C-H stretching. The C–N stretching occurred at 2126 – 2109 cm^{-1} while the carbonyl (C=O) stretching vibration appeared at 1689 – 1620. The azo (-N=N-) band occurred in the region of 1436 – 1420 cm$^{-1,}$ which is a stretching vibration of the azo group. A strong band at 1006 – 991 cm^{-1}is due to the stretching vibration of S=O while the band at 879 – 864 cm^{-1}is due to the stretching vibration of C-Cl followed by C-Br group stretching vibration appearing at 790 - 745. The result depicts the characteristic azo dye which according to literatures, can be easily reduced under mild reducing conditions, (sometimes even with the help of some enzymes in the human body) splitting into forbidden aromatic amines such as benzidine, aniline and their derivatives, which are dangerous to humans also some of these toxic chemicals find their way into the environment which are hazardous to the ecosystem. Teachers and caregivers are therefore advised to take important notice of their pupils and guide them properly to use water colours appropriately and any cases of injection by pupils should be reported to the nearest health centre. However, the FT-IR spectroscopy of the water colours studied here did not reveal the chemical structure of the dyes; there is a need to carry out GCMS or NMR of the colours in order to determine their chemical structure.

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