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EXTRACTION, CHARACTERIZATION AND WORKABILITY OF SOME LOCAL PLANT DYES AS ACID-BASE INDICATORS

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ABSTRACT

Today, as a result of environmental pollution as well as the global economic chrunch, there became a growing need to utilize indigenous natural resources as materials in the laboratory due to there environmental friendliness, easy availability, and lower price compared to the synthetic standard indicators. The study was therefore carried out to investigate the indicator properties of ethanolic extracts of different parts of four local plants; hibiscus rosasinesis, mangifera indica, zingiber officinale and cola accuminata. A comparative study of these plants extracts with available standard indicators-methyl orange and phenolphthalein was carried out to evaluate the accuracy and workability of local plant dyes as acid-base indicators. The results which were similar to that of the standard indicators indicated that plant extracts can be used as acid-base indicators in titration of strong acid with a strong base, and also weak acid with strong base.

KEYWORDS: Plant Extracts, Dyes, Indicators, Titration

INTRODUCTION

Dye is a soluble coloured compound which is a widely used material in almost all industries. The preparation and application of dyestuffs is one of the oldest forms of human activities. Many garden flowers make beautiful dyes ranging from yellow to orange and brown. Several workers have extracted a number of dyes from a variety of local plants. According to Akpuaka (1998) and Osabohiem (2002), the local plants like canwood, redwood, henna, banana, annatto, rothmania, indigovine, kola turmeric, Rosette and ginger all contain different types of dyes which are used for various purposes.

The suitability of some of these dyes for dying purposes has been investigated on different types of fabric. Another plant that will make a beautiful dye is onions skin; onions skin will produce a beautiful orange colour with alum and tartaric acid (Akpuaka, 1993). An evaluation of other properties of a number of dyes including synthetic dyes has also been reported by a number of workers (Obanda et al, 1997; Dambata et al, 1997). Ekandern et al, (1997); Eze et al, (2002); Yakasai et al, (2005); Izonfuo et al, (2000) and Sudarshan et al, (2011) have also reported their findings on the use of some natural dye extracts as indicators in acid-base titrimetry. Other than these few reported cases, very little attention has been paid to the use of local plant dye extracts as indicators in acid-base titrimetry. Several types of indicators are available for different types of titrimetric analyses.

For acid-base titrations, organic dyes, which are either weak acids or bases, serve excellently as indicators (Izonfuo et al., 2006). Indicators used in titrations show well marked changes of colour in certain intervals of pH.

Today synthetic dyes are the choice of acid-base titrations but due to environmental pollution, availability, ease of preparation and cost effectiveness, the search for natural compounds as acid-base indicators started. With regards to using plant dyes in titrimetric analysis, Oloyede, (1997) and Ochonogor (2000) reported that extract from hibiscus flower compare favourably with phenolphthalein as indicator for weak base-strong acid titration. Akpuaka and Inyang (1998), reported that ginger dye is a working substitute for methyl orange indicator.

Thus the purpose of this study is to extract and investigate some local plant dyes that could be used as effective substitutes or compliments to standard indicators in acid-base titrations as well as their workability as good indicators.

MATERIALS AND METHODS

Sampling and Sample Preparation

Some plants with coloured parts in the local environment were selected as shown in table 1 below

Table 1: Plants / Plant Parts Selected for the Study

S/N	Common Name	Botanical Name	Part Used	Colour
1.	Hibiscus	Hibiscus rosa sinensis	Flower	Red
2.	Mango	Mangifera indica	Seed	White
3.	Ginger	Zingiber officinale	Stem	Green
4.	Kolanut	Cola acuminate	Seed	Pink

Three of the selected plant parts namely, mango, ginger and kolanut were dried separately in the sun for five days. The dried samples were separately ground to powder and, 30g of each of the ground dry samples were placed in three separate 250 cm^3 beakers labeled A, B and C. Fresh hibiscus flowers were ground to a paste and 50g of it weighed and placed in 250cm^3 beaker labeled D. 150cm^3 of ethanol was introduced in each of the beakers labeled A – D and left for three hours. The reaction mixtures were filtered and the filtrate evaporated to dryness using a sand bath. The residue was weight heated further and reweighed until a constant weight was obtained. The percentage yield of each extract was calculated. The solubility of the dye samples in cold water, dilute methanol (CH_3OH) and dilute ethanol (C_2H_5OH) were determined.

The colour change of plant dye indicators in neutral, acidic and alkaline solution as well as the pH range at which the changes occurred, were also determined. Demonstrated acid-base titrations were performed with strong acid/strong base as well as weak acid/strong base using the extracted dyes as indicators. Similar titrations were also performed using available standard indicators (methyl orange and phenolphthalein). All the reagents used were of analytical grade. The pH ranges over which the dyes changed colour were also measured.

RESULTS AND DICUSSIONS

Percentage Yield

Table 2: The Percentage Yield of the Plant Dyes

Plants	Mass of Plant Powder (Paste)	Mass of Dye Obtained	Percentage Yield (%)
Hibiscus flower	50g	0.82	1.64
Mango	30g	2.93	9.77
Ginger	30g	1.52	5.07
Kolanut	30g	1.98	6.6

Solubility of the Plant Dyes

The results obtained for the solubility of 0.05g of plant dyes in 60cm^3 each of distilled water, 30% methanol/water and 30% ethanol/water are shown in Table 3.

Table 3: Solubility of Plant Dyes

Dyestuff	Cold Water	30% Methanol/Water	30% Ethanol/Water
Hibiscus	Soluble	Soluble	Soluble
Mango	Insoluble	Soluble	Soluble
Ginger	Soluble	Soluble	Soluble
Kolanut	Insoluble	Soluble	Soluble

Determination of Colour and pH Change

The result of the determination of colour and pH change of the selected plant dyes in neutral, acidic and alkaline solution are shown

Table 4: Colour Change of Plant Dyes Colour Change of the Dye Sample

Dyestuff	Color of the Dye	No of Drops	Basic	Acidic	Neutral	pH Range
Hibiscus	Dark coffee	10	Yellow	Pink	Pinch Pink	4.8 -6.4
Mango	Yellow	3	Light brown	Pink	Pinch brown	4.5-61
Ginger	Orange	3	Orange	Green	Pale Green	5.5 – 6.8
Kolanut	Yellow	10	Light red	Colourless	Colourless	4.0-5.6

Titration

The result of the comparison of the plant dyes with standard indicators are shown in tables 5and 6.

Table 5: Comparison of Dye Extracts with Standard Indicators in 0.05 mol/dm of Strong Acid vs Strong Base Titration Vol (cm^3) of Acid

Titration	Vol. of Base (NaOH) cm^3	HCI in cm^3	Titre Vol(cm^3) of Acid					
			Ginger	Mango	Hibiscus	Kolanut	Methy orange	Phenolpthaline
1st	25.00	60.00	25.20	24.60	24.70	23.50	24.80	25.30
2nd	25.00	60.00	24.60	24.40	24.60	23.30	24.75	25.10
3rd	25.00	60.00	25.30	24.40	24.40	23.30	24.80	25.10
Average Titre(cm^3)			25.03	24.46	24.56	23.36	24.78	25.16

Table 6: Comparison of Dye Extracts with Standard Indicators in 0.05m Weak Acid vs Strong Base Titration

Titration	Vol. of (NaOH) in Cm^3	Vol of CH_3 COOH	Titre Vol(cm^3) of Acid					
			Ginger	Mango	Hibiscus	Kolanut	Methy orange	Phenolpthaline
1st	25.00	60.00	25.70	23.10	25.40	21.10	25.10	25.20
2nd	25.00	60.00	26.30	23.30	26.60	21.30	25.95	25.85
3rd	25.00	60.00	26.30	22.70	26.40	21.20	26.20	26.10
Average Titre(cm^3)			26.06	23.10	26.46	21.23	25.75	25.72

In strong acid, strong base titration, the average titre value for ginger is 25.03cm^3, mango 24.46cm^3, hibiscus 24.56 cm^3 & kolanut 23.36 cm^3, where as methyl orange shows a titre value of 24.78cm^3 and phenolphthalein 25.16 cm^3. These results indicate that ginger, hibiscus and mango dyes compare favourably with methyl orange and phenolphthalein.

A comparison of result of titration of weak acid (CH_3OOH) against strong base (NaOH) using these plant extracts as indicators as presented in table 6 indicate that the average titre using ginger dye is 26.06cm^3 hibiscus, 26.46, kolanut 21.23 and mango 23.10cm^3 while that of methyl orange and phenolphthalein are 25.75cm^3 and 25.72 respectively. Ginger and hibiscus dyes compare better to methyl orange than mango and kolanut dye though these results are also comparable, considering that the reaction is with (CH_3OOH) a weak acid. Hence, the dye extracts compared favourable to standard indicator methyl orange in acid/base titrations.

In monitoring strong acid/strong base and weak acid / strong base titrations, these observations confirmed the earlier findings of Akpuaka and Inyang (1998) who reported that ginger dye is a workable substitute for methyl orange, while findings of the researchers showed that mango and hibiscus dyes are other workable substitutes for methyl orange.

However, with regards to the effectiveness of hibiscus flower, and kolanut dyes as acid-base indicator, the observation from this study showed that though the kolanut and hibiscus dyes have distinct colour change in acidic and basic solution, their sensitivity required a large volume of up to 10 drops each to bring about the colour change. This observation also confirmed the earlier findings of Ochonogor (2000), who said that extract from hibiscus flowers compare favourably with phenolphthalein as indicator for weak-base/strong acid titration.

The findings of the researchers also showed that ginger dye is another workable substitute for phenolphthalein in monitoring strong acid/strong base and weak acid/strong base titrations. The result of this study showed that the four local plants selected for the study, three namely: ginger, mango, and hibiscus dyes met the requirement of good indicators.

CONCLUSIONS & RECOMMENDATIONS

Based on the findings of this study, it is hereby concluded that mango, ginger, and hibiscus dyes could serve as veritable substitutes in acid – base titrations. However due to the nutritional and economic values of ginger, we recommend that hibiscus flower and mango seed dye extracts be used so as not to create scarcity of ginger.

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