The Extraction of the Constituents of Some Selected Local Plants from Abakaliki as Acid-Base Indicatorsusing Distilled Water, Methanol and Chloroform.

*1Nwokonkwo, D.C., 2Nwokonkwo, H.C., 3Aninkpu, P.C
*Faculty of Science, Industrial Chemistry Department Ebonyi State University Abakaliki, Nigeria.
*1mirinkwa@gmail.com

ABSTRACT: The extraction of the constituents of some selected local plants- Ixora coccinea, Hibiscus sabdarriffa (zobo), Baphia nitida (red and yellow camwood), Curcuma lunga (tumeric) and Tectona grandis (teak leaves) from Abakaliki using distilled water, methanol and chloroform as solvents was carried out. The indicator properties of these plant constituents/extracts in acid-base media were determined. A comparative study of these plant extracts with available standard indicators (methyl orange and phenolphthalein) was done to evaluate the accuracy and workability of these plant extracts as acid-base indicators. The results obtained were similar to those of the commercial/ standard indicators and showed that these plant extracts could be used as acid-base indicators for volumetric analysis for strong acid with strong base, strong acid with weak base, weak acid with strong base and weak acid with weak base media.

Key words: Acid, Base, Extracts, Indicators, Media, Plants, Volumetric analysis

1 INTRODUCTION

In the past all dyes, indicators and paints were obtained from nature- directly from animals such as lac, cochineal, kermes; from minerals such as various inorganic metal salts and metal oxides and plants such as roots, flowers, foliage, nuts, trunk, fruit, bark, berries etc [1], [2], [3], [4],[5].

These indicators which were natural dyes were simple to apply and were environmentally friendly and cheap compared to their synthetic analogues which were manmade which though in some cases might have better properties, cheaper in a way, available in commercial quantity but were toxic and not environmental friendly [6].

Indicators are colourants which could be both natural and synthetic, and are characterized by their ability to absorb or emit light in the visible region of the electromagnetic spectrum and man has used these natural colourants for decades. Indicators as dyes could be used in the staining of biological tissues, paper, leather, woods, pharmaceuticals, food, cosmetics etc [7].

An indicator is an organic dye or pigment used to point out when two or more reactants are in equilibrium [8]. It can also be defined as a coloured substance or a dye used to indicate the end point in titration in volumetric analysis; examples include phenolphthalein, methyl orange, methylene blue, methyl red to mention but a few; which are used in acid-base titrations [9], [10],[11].

An indicator causes a colour change at different conditions or what might be referred to as different pH. Many substances have been used as indicators to determine the equilibrium of reaction, the choice of indicator depends on the strength of the acid and base used, and most indicators are themselves weak acids. Plant pigments in flowers and leaves undergo a change in the electronic structure along with the removal of a hydrogen ion from the molecule. The pigment shows different characteristic colour change as the colour of hydrogen and metallic ions change in solutions. The utilization of natural dyes obtained from plants especially as indicators in acid-base titrations have been reported by researchers [12], [13].[14].

Some naturally occurring flavones, flavonols, anthocyannins are pH sensitive. These exhibit different colours in acid-base medium and give sharp distinct and stable colour change on a change from acid to alkaline medium and vice versa [3].

2 GENERAL EXPERIMENTAL PROCEDURES

All reagents were of analytical grade and pur-

chased from BDH Chemical Ltd. Poole England. The pH meter used was Orion Sure-Flow Ross pH-electrode from SSS Reagent Co. Ltd. Shanghai. Weighing was done on Mettler P2010.

2.1 Sample Collection and Preparation

Approximately 1 kg of flowers of dry sample of *Hibiscus sabdariffa* (zobo) was purchased from Meat Market Abakaliki, Ebonyi State in May 2014 while fresh sample of the flowers of *Ixora coccinea* was handpicked from the office complex of Faculty of Science Ebonyi State University Abakaliki in June 2014. Both samples were identified by the Applied Biology Department Faculty of Science Ebonyi State University. Also, 1 kg stems of *baphia nitida* (red and yellow species) and yellow rhizomes of curcuma lunga (tumeric) were collected from a forest in Ikwo community of Abakakliki Ebonyi State, Nigeria while the same quantity of the green leaves of *tectona grandis* (teak leaves) were collected from Amagu in Abakaliki metropolis of Ebonyi State in the same month of June 2014.

2.2 Identification of Plant Samples

The plant materials were identified in the Department of Applied Biology Faculty of Sciences Eboyi State University by Prof. C. Onyekwelu.

2.3 Sample Preparation

Approximately 1000 g of each sample was washed with distilled water to remove sand and dirt and air dried for seven days. The dried samples were pulverized separately and stored in air tight cellophane until ready for use.

2.4 Extraction of Constituents of the Plant Samples

Approximately 100 g of *Hibiscus sabdariffa* (zobo) and *Ixora coccinea, Baphia nitida* (red and yellow species), yellow rhizomes of *Curcuma lunga* (tumeric) and Tectona *grandis* (teak leaves) were taken and soaked in 500 mL of different solvents: chloroform, methanol and distilled water and left to stand for 21 day to achieve an appreciable exhaustive extraction of the active constituents in the plant samples. The solutions of the samples were filtered and the filtrates evaporated to dryness to reveal 5.6 g of *Hibiscus sabdariffa* chloroform extract (HSCE), 24.47 g *Hibiscus sabdariffa* methanol extract (HSME) and 34.28 g *Hibiscus sabdariffa* aqueous extract (HSAE). *Ixora coccinea* yielded 5.82 g choloroform extract (ICCE), 20.10 g methanol extract (ICME) and 57.71 g aqueous extract (ICAE). About 3.06 g of *Cucuma lunga* chloroform extract (CLCE), 32.45 g *Curcuma lunga* methanol extract (CLME) and 15.30 g *Curcuma lunga* aqueous extract (CLAE) were obtained. In addition, 9.21 g yellow *Baphia nitida* chloroform extract (1BNCE), 14.57 g yellow *Baphia nitida* methanol extract (1BNME) and yellow *Baphia nitida* aqueous extract (1BNAE) were recovered as filtrates. Also, 9.24 g red *Baphia nitida* chloroform extract (2BNCE), 25.65 g red *Baphia nitida* methanol extract (2BNME), and 5.58 g red *Baphia nitida* aqueous extract (2BNAE) were recovered. Again, 6.62 g *Tectona grandis* chloroform extract (TGCE), 3.69 g *Tectona grandis* methanol extract (TGME) and 39.61 g Tectona grandis aqueous extract (TGAE) were extracted. All the samples were soluble in ethanol and sparingly soluble in water except *Tectona grandis* that was soluble in the two solvents.

2.5 Preparation of Plant Sample as Indicators for Titration

About 500 mg of each extract was dissolved in 50 mL of 96 % ethanol and set aside as the indicator.

2.6 Preparation of Methyl Orange and Phenolphthalein Indicators

About 500 mg of methyl orange and 500 mg of phenolphthalein were dissolved in 50 mL of ethanol respectively and set aside for use as standard indicators.

2.7 Titration using the Plant Pxtracts

Standard or one molar solution (1M) of HCl, CH_3COOH, NaOH and NH_4OH were prepared respectively. Fifty milliliter (50mL) of 1.0 M HCl or 1.0 M CH_3COOH were titrated with against 25 mL of 1.0 M NaOH or 1.0 M NH_4OH using three drops of the extracts as indicators: in the order of strong acid/ strong base (1.0 M HCl/1.0 M NaOH); strong acid /weak base (1.0 M HCl /1.0 M NH_4OH); weak acid/ strong base (1.0 M CH_3COOH/1.0 M NaOH) and weak acid/ weak base(1.0M CH_3COOH/1.0 M NH_4OH).
The same procedure was followed for similar titration using three drops of methyl orange and phenolphthalein as standard indicators.

3 RESULTS

The percentage yield of the plant materials from 100 g of each sample used is shown below as Table 1. Table 2 is the mean volume of the base used in mL and the equivalent points of the acid-base titration for both the standard indicators: phenolphthalein and methyl orange and the plant samples.

Table 1

Percentage Yield of the Plant Material

Plant	Weight of plant used (g)	Weight of filtrate (g)	% yield
HSCE	100	5.6	3.79
HSME	100	24.47	12.24
HSAE	100	34.28	22.85
ICCE	100	5.82	3.88
ICME	100	20.10	13.40
ICAE	100	57.71	38.47
CLCE	100	3.06	3.06
CLME	100	32.45	22.45
CLAE	100	15.30	15.30
1BNCE	100	9.21	4.61
1BNME	100	14.57	7.29
1BNAE	100	43.55	21.78
2BNCE	100	9.24	4.61
2BNME	100	25.65	12.78
2BNAE	100	5.58	2.79
TGCE,	100	6.62	3.31
TGME	100	3.69	1.85
TGAE	100	39.61	19.81

4 DISCUSSIONS

In Table 1, it could be observed that water was the best solvent for the extraction of the constituents of *Hibiscus* sabdariffa and *Izora* coccinea, yellow *Baphia nitida* and *Tectona grandis*, methanol could also be used as was seen in the quantity of *Hibiscus sabdariffa* using methanol (HSME) and *Ixora coccinea* (ICME). Methanol was the best solvent for the extraction of the constituents of *Curcuma lunga* and red *Baphia nitida*. While water was a good solvent for yellow *Baphia nitida* (1BNAE), it was a poor solvent for red *Baphia nitida* (2BNAE). Yellow *Baphia nitida* gave a high yield using methanol (1BNME) than chloroform (1BNCE). For *Tectona grandis*, chloroform served as a better solvent for extraction (TGCE) compared to methanol (TGME). Chloroform was generally a very poor solvent for the extraction of the various plant samples.

The results in Table 2 shows that 1BNAE, TGCE and CLME gave similar equivalent points ranging from 26.67±0.002- 27.47±0.002 which were close to the equivalent point obtained using of methyl orange in strong base-strong acid titration. HSAE (28.23±0.02) and ICAE (28.37±0.01) gave equivalent points very close to that obtained using Phenolphthalein (28.70±0.001), therefore in a titration involving strong acid/ strong base the aqueous extracts of *Hibiscus sabdariffa* and *Ixora coccinea* would serve as good alternatives.

Again, CLCE, 1BNCE and 1BNME with equivalent points ranging from 29.40±0.01-30.10±0.003 gave close equivalent points with the commercial phenolphthalein which gave equivalent point of 28.70± 0.01 in strong base- strong acid titration. For weak acid- strong base titration, HSCE (32.17±0.001) and 1BNCE (32.80±0.001) gave close equivalent point to phenolphthalein (31.83±0.002) for the same reaction; CLCE (33.13±0.002) and 1BNME (33.53±0.003) could serve as close substitutes to phenolphthalein also. For strong acid- weak base, ICME (11.67±0.01) gave a close equivalent point to Methyl orange, a difference of 0.47 mL. Though 2BNME (12.35±0.003) and CLCE (12.80±0.01) could be used effectively in the absence of methyl orange (11.20±0.03). While, TGAE (10.83±0.002), could be a very good substitute to Phenolphthalein (10.67±0.002); a difference of 0.16 mL. The plant samples were not suitable for weak acid-weak base titrations like phenolphthalein (12.80±0.001) except 1BNCE 13.35±0.003 and ICME (13.57±0.01).

HSCE showed no end point in strong acid/ strong base, strong acid/weak base and weak acid/weak base media. HSAE was end point in the reaction between weak acid and strong base. ICCE showed no conclusive equilibrium points in strong acid versus weak base and weak acid and weak base. ICAE gave no result in weak acid versus strong base, strong acid versus weak base and weak acid and weak base. Plant extracts CLAE and 2BNAE showed no change and thus no end point.

The plant samples used in this article are materials that could be easily obtained and are common plants that grow in this part of the world. They could be easily accessed and used as indicators for chemistry practicals in secondary and tertiary institutions. The health and environmental problems posed by synthetic indicators/compounds of which colourants are included cannot be overemphasized; hence natural indicators/products are gaining attention because of their safety, non toxicity and environmental friendliness. The extracts from these plant species may be useful as indicators of this century.

CONCLUSION

The availability of synthetic indicators in general and phenolphthalein and methyl orange in particular, in this part of the world, is scarce at times due to the problem of sourcing/ importation and adulteration; thus the extracts from these plant samples could serve as alternative replacements for phenolphthalein and methyl orange indicators.

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Table 2

Mean Titre volume of base used and the end points

Indicator	Type of Reaction			
	HCl/NaOH(mL)	CH_3COOH/NaOH(mL)	HCl/NH_4OH(mL)	CH_3COOH/NH_4OH(mL)
Methylorange	27.40 ±0.01	NE	11.20±0.03	NE
Phenolphthalein	28.70±0.001	31.83±0.002	10.67±0.002	12.80±0.001
HSCE	NE	32.17±0.001	NE	NE
HSME	30.10±0.02	38.15±0.01	24.10±0.02	14.70±0.01
HSAE	28.23±0.02	NE	26.20±0.01	29.00±0.02
ICCE	10.30±0.002	26.60±0.01	NE	NE
ICME	30.47±0.02	26.60±0.01	11.67±0.01	13.57±0.01
ICAE	28.37±0.01	NE	NE	NE
CLCE	29.40±0.01	33.13±0.002	12.80±0.01	14.70±0.01
CLME	27.47±0.002	NE	17.27±0.002	16.17±0.002
CLAE	NE	NE	NE	NE
1BNCE	30.10±0.01	32.80±0.001	13.83±0.002	13.35±0.003
1BNME	30.05±0.003	33.53±0.003	13.43±0.003	19.27±0.01
1BNAE	26.67±0.002	NE	NE	NE
2BNCE	32.15±0.003	20.15±0.01	28.73±0.002	20.07±0.01
2BNME	33.05±0.003	28.70±0.01	12.35±0.003	11.15±0.003
2BNAE	NE	NE	NE	NE
TGCE,	26.77±0.002	34.10±0.01	NE	NE
TGME	NE	NE	NE	NE
TGAE	23.17±0.002	NE	10.83±0.002	27.05±0.003

NE = No end point