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EXTRACTION AND APPLICATION OF SOME NATURAL FLOWER PIGMENTS AS ACID-BASE INDICATORS

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ABSTRACT

In this study, the pigments of Ixora coccinea, Lantana camara, Moringa oleifera, Nerium oleander, and Sensevieria trifasciata were used to identify the natural indicators for acid-base titrations using 0.1% acidified ethanolic solvent. The Potiskum Vetenary, biological gardens of Federal University Gashua and Umar Suleiman College of Education Gashua were used to collect the samples. All three types of acid-base titrations—strong acids against strong bases, strong acids against weak bases, and weak acids against strong bases—were studied. Calculations were made for the indicator's color change, the pH at the relevant point and the average titre values for each type of acid-base titration. According to the data, there was no appreciable difference between the mean titre values of methyl orange and Ixora c. flower extract in strong acid against weak base. Moringa o. flower extract can be used in place of methyl orange and phenolphthalein for strong acid against strong base, strong acid against weak base and weak acid against strong base titrations. Nerium o. flower extract can be used in place of phenolphthalein in weak acid against strong base titrations. Sensevieria t. flower extract can be used in place of methyl orange in strong acid against weak base titrations and phenolphthalein for strong acid against strong base and weak acid against strong base titrations. In all acid-base titrations, lantana c. flower extract had no discernible reaction. Most of the extracts proved to be a good substitute for synthetic acid-base indicators. Using these harmless and readily available flowers is recommended.

Keywords: Flower pigments, acid-base indicators, extraction, health hazards, anthocyanins, flavonoids

INTRODUCTION

The increasing scarcity and high expense of conventional science teaching resources are factors that work against science education in Nigeria (Along, 2010; Garba, 2013). This has jeopardized the chance for students to get more scientific information and contribute to national growth. Over the years, scientists have conducted cost-focused research on the usage of indigenous resources. One such locally available material that might be utilized in science lessons in place of artificial indicators is the flower. According to Muhammad *et al*. (2011), synthetic (standard) acid-base indicators are extremely hazardous and dangerous. Synthetic acid-base indicators in effluents prevent them from degrading naturally and they occasionally do so under anaerobic circumstances, where they can produce more dangerous chemicals (Shih *et al.,* 2010).

Numerous studies have shown that convectional synthetic acid-base indicators can cause cancer, mutation, and genotoxicity in both people and aquatic species (Altangerel *et al*., 2014). The waste water from laboratories that uses synthetic indicators increases the concentration of chemical and biological contaminants in drinking water and is known to cause waterborne and water-related diseases (Ojimma and Joshua, 2022). Methyl red irritates the gastrointestinal and respiratory tracts, phenolphthalein thins the intestinal wall and alters the terminal ileum's normal mucosal pattern, and phenol red is bad for the heart and central nervous system and can cause disrhythmias, coma and seizures (Jain *et al*., 2013). As a result, the health risks associated with synthetic indicators will be reduced by using plant extracts from flowers, leaves, and roots as natural acid-base indicators.

Various research on the use of plant extracts as an alternative to synthetic acid-base indicators in titrations have been conducted. Natural indicators were obtained from *Aspilia Africana* and *Urena Labata* (Mgbo) flowers by Eze and Ogbuefi (Suva, 2014), *Gerbera jamasonii and Tagertes erecta* flowers by Shivaji *et al.*, (2014), flowers of *Ipomea nil* and *ipomea biloba* by (Abbas , 2012), flowers of *Bougainvillea Spectabilis* by Bagul *et al.*, (2012) *Jacaranda acutifolia* and *Ixora Coccinea* flowers by Masoud *et al.*, (2012), flower sap of China rose by Gupta *et al.*, (2012), petal sap of *Delonix regia* 12 by Jain *et al.,* (2013), golden beet root, *mangifera indica* seed by Onwuachu *et al., (*2014), and blood leaf (*Iresine herbstii*) by Doctor *et al.,* (2014).

Anthocyanins, organic pigments that change color with pH, are present in nearly all plants having blue, violet, purple, or red flowers (Gupta *et al*., 2012). Anthocyanins' color stability is influenced by their chemical make-up, pH, temperature, oxygen content, light exposure, and water activity (Bondre *et al*., 2012). In a more acidic solution, they usually appear red, and in a more basic solution, blue. Anthocyanins are safe to employ in acid-base titration because they have a variety of biological properties, including cancer chemopreventive, anti-inflammatory, anti-tumor, hypolidemic, antioxidant, cardioprotective, and antihepatocarcinogenic (Malik and Targonski, 2006).

Natural indicators' color variations at various pH levels have been related to the presence of anthocyanins and flavonoids, which are pH sensitive (Suva, 2014). Organic substances called anthocyanins are typically present in the sap that collects in the vacuole of epidermal plant cells. A complicated three-ring aromatic molecular region, one or more connected sugar molecules, and occasionally sugar molecules with acyl groups attached make up the structure of these substances. In general, anthocyanins are more stable in acidic media than in alkaline solutions and are water soluble (Mohammed, 2011). This research will offer a substitute for the poisonous and damaging synthetic acid-base indicators and provides a more user- and environmentally-friendly indicator that is affordable and easily accessible.

Volumetric Analysis and the Use of Acid-Base Indicators

According to Eze and Ogbuefi (2014), a pH indicator is a halo-chromic chemical substance that is diluted and introduced to a solution or analyst sample to assess its acidity or alkalinity. According to Bart *et al*. (2011), pH indicators are hydronium ions (H_3O^+) or hydrogen ions (H^+) detectors in the Arrhenius model that change color depending on their ion concentration. Due to variations in their absorption spectra, weak acids and bases frequently exhibit acid or conjugate base forms with distinct colors (Bhise *et al*., 2014). With a pH range of 8.3 to 10, for example, phenolphthalein changes color. The indicators' ability to donate or collect electrons causes their color to fluctuate as the pH (acidity or alkalinity) changes. According to Jain *et al*. (2013), volumetric analysis is the quantitative determination of an unknown material by calculating the volume of a solution with a known concentration that quantitatively reacts with the measured volume of the unknown solution. In volumetric analysis, the endpoint of the reactions is identified using pH indicators. Table 1 displays the pH range for several indicators.

Table 1: pH range of some indicators

S/N	Indicators	In Alkaline Medium	In Acidic Medium	pH Range
1	Alizarin yellow	Red	Yellow	10.1–12.0
2	Bromothymol blue	Blue	Yellow	6.0 – 7.6
3	Litmus paper	Blue	Red	5.0 – 8.0
4	Methyl orange	Yellow	Red	3.1 – 4.6
5	Methyl red	Yellow	Red	4.4 – 6.3
6	Methyl violet	Violet	Yellow	0.0 – 1.6
7	Phenolphthalein	Pinks	Colourless	8.3 – 10.0

MATERIALS AND METHODS

Samples Collection

Five different flowers sample were collected viz; *Ixora coccinea* from faculty of science Federal University Gashu'a 11.8 E and 13.7 N, *Moringa oleifera* from biological garden Federal University Gashu'a 11.12 E and 13.15 N, *Neriun oleander* and *lantana camara* from biological garden College of Education Gashu'a 13.3 E and 14.8 N and *Sensevieria trifasciata* from Potiskum veterinary 28.11 E and 13.7 N in February, 2020. All the samples were collected by hand picking and were identified in the Department of Biological Science, Umar Suleiman College of Education Gashu'a, Yobe State.

Samples Extraction Procedure

All of the samples were cleaned with distilled water to get rid of contaminants and dried for a week at room temperature. The flowers were grinded into powdered form using mortar and pestle. About 2g of the powdered sample was transferred into 250ml volumetric flask, in the flask, 50cm3 of 0.1% HCl in ethanol were added, the solution was shaken vigorously for about 15 mins. The solution was filtered to remove the active extract using Whatmann filter paper and the filtrate was transferred into a clean labeled container. The procedure above was repeated for the remaining four flower samples. The extracts were allowed to evaporate to half of their initial volume.

Titration Procedure

In 10cm3 of 0.2M KOH, 3 drops of ixora extract were added, and the solution was titrated against 0.2M HCl. The titration was done in triplicate to obtain average titre values. The procedure above was repeated with 0.2M KOH against CH_3COOH and 0.2M NH_3 against 0.2M HCl.

The procedure above was carried out using the remaining extracts and also with synthetic indicators (Methyl orange and phenolphthalein). The experiment was carried out in Chemistry laboratory Federal University Gashua at room temperature. pH value was determined at each equivalent point using pH meter (PHS-25).

RESULTS AND DISCUSSION

Table 2 displays the extracts of the flowers' visible colours

Table 2: Physical appearances of the flowers' extracts

Plants	Colour of extract
Ixora coccinea	Red
Lantana camara	Red orange
Moringa oleifera	Yellow
Nerium oleander	Dark yellow
Sensevieria trifasciata	Dark brown

Titration Result using Synthetic Indicators

Table 3 displays the results of titrations of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH).

Table 3: End point titre value and colour change for three titrations using synthetic indicator

Titration	Indicator	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	Methyl orange	8.80+8.70+8.50	Red-Pink	7.20
	Phenolphthalein	12.00+11.80+11.70	Purple-colourless	6.90
HCl vs NH_3	Methyl orange	5.60+5.60+5.50	Red-Pink	7.90
CH_3COOH vs KOH	Phenolphthalein	6.20+6.10+6.00	Purple-colourless	6.30

Titration Result Using *ixora c.* Extract

The Ixora c. extract was used in the titration of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH), and the results are shown in Table 4.

Table 4: End point titre value and colour change for three titrations using *ixora c*. flower extract

Titration	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	4.10+4.20+4.00	Green-brown	7.10
HCl vs NH_3	5.80+5.70+5.90	Green-pale orange	8.00
CH_3COOH vs KOH	4.80+4.70+4.60	Green-brown	6.00

Titration result using *lantana c*. Flower extract

The results of the titration of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH) using Lantana c. extract was utilized as an acid base indicator.are shown in Table 5.

Table 5: End point titre value and colour change for three titrations using *Lantana c*. flower extract

Titration	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	No visible reaction	No colour change	3.70
HCl vs NH_3	No visible reaction	No colour change	3.00
CH_3COOH vs KOH	No visible reaction	No colour change	3.10

Titration Result Using *Moringa o*. flower extract

The results of the titration of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH) using Moringa o. extract was utilized as an acid base indicator are shown in Table 6.

Table 6: End point titre value and colour change for three titrations using *Moringa o*. flower extract

Titration	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	8.30+8.10+8.00	Yellow green-colourless	7.40
HCl vs NH_3	6.00+5.90+5.70	Yellow green-colourless	7.9
CH_3COOH vs KOH	6.20+6.10+6.00	Yellow green-colourless	6.10

Titration result using *nerium o.* Flower extract

The results of the titration of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH) using Nerium o. extract was employed as an acid base indicator are shown in Table 7.

Table 7: End point titre value and colour change for three titrations using *Nerium o.* flower extract

Titration	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	5.30+5.20+5.00	Yellow green-Brown	7.10
HCl vs NH_3	3.00+2.90+2.90	Pale green-Pale orange	8.5
CH_3COOH vs KOH	6.20+6.00+5.00	Yellow green-Brown	6.03

Titration Result Using *Sensevieria t.* Flower Extract

The results of the titration of strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH) using the Sensevieria t. extract as an acid base indicator are shown in Table 8.

Table 8: End point titre volume and colour change for three titrations using *Sensevieria t*. flower extract

Titration	End point result (cm^3)	Colour change	pH at equivalent point
HCl vs KOH	11.80+11.70+11.60	Pale yellow-colourless	6.80
HCl vs NH_3	5.50+5.30+5.40	Pale yellow-colourless	8.10
CH_3COOH vs KOH	7.70+7.60+7.40	Pale yellow-colourless	6.20

Comparison of Synthetic Indicators with Natural Indicators (Flower Extracts)

Table 9 displays the results of the titrations using synthetic and natural indicators with strong acid against strong base (HCl and KOH), strong acid against weak base (HCl and NH3), and weak acid against strong base (CH3COOH and KOH) of both extracts. The results of these titrations were different for each indicator and were expressed as mean ± standard deviation.

Table 9: Table of comparison of synthetic indicators with natural indicators.

Titration	Indicator	Colour change	Mean ± SD	pH at equivalent point
	Methyl orange	Red-pink	8.66±0.1530	7.20
	Phenolphthalein	Purple-colourless	11.83±0.1783	6.90
	Ixora c.	Green-brown	4.10±0.1	7.10
HCl vs KOH	*Lantana c.*	No visible reaction	------------	3.70
	Moringa o.	Pale green-colourless	8.13±0.1530	7.40
	Nerium o.	Yellow green-Brown	5.17±0.1530	7.10
	Sensevieria t.	Pale yellow-colourless	11.70±0.1	6.80

HCl vs NH_3	**Methyl orange**	Red-pink	5.56±0.0583	7.90
	Ixora c.	Green-pale orange	5.58±0.1	8.00
	Lantana c.	No visible reaction	----------	3.00
	Moringa o.	Pale green-colourless	5.87±0.1530	7.90
	Nerium o.	Pale green-Pale orange	2.93±0.0583	8.50
	Sensevieria t.	Pale yellow-colourless	5.40±0.1	8.10
CH_3COOH vs KOH	**Phenolphthalein**	Purple-colourless	6.10±0.1	6.30
	Ixora c.	Green-brown	4.70±0.1	6.00
	Lantana c.	No visible reaction	-----------	3.10
	Moringa o.	Pale green-colourless	6.10±0.1	6.10
	Nerium o.	Yellow green-Brown	6.03±0.1150	6.03
	Sensevieria t.	Pale yellow-colourless	6.57±0.1528	6.20

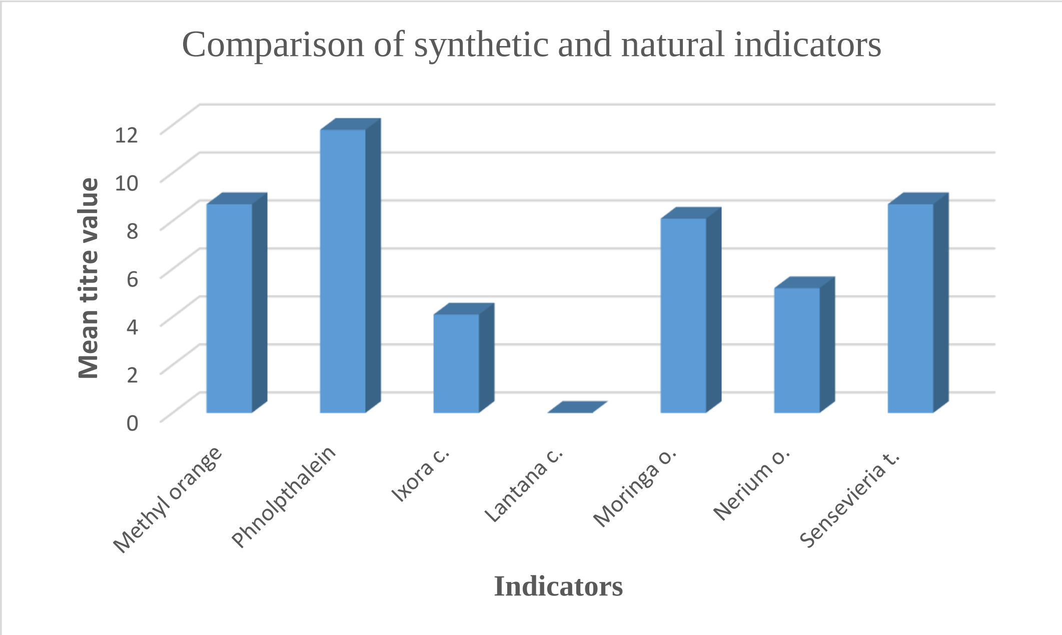

Figure 1: Titration Bar chart of Strong acid (HCl) against Strong base (KOH)

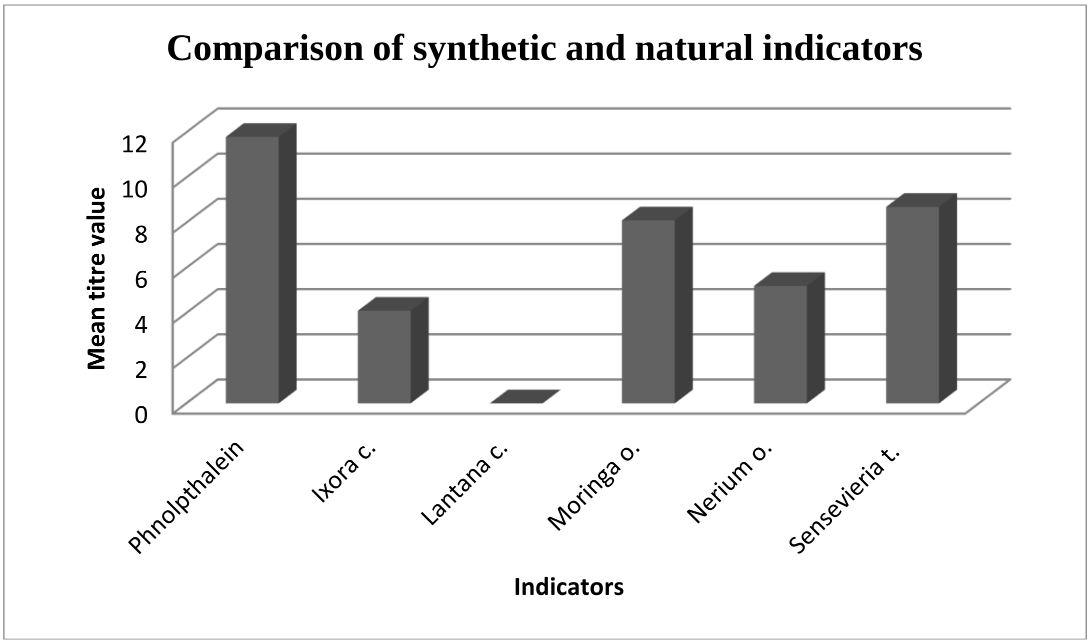

Figure 2: Titration Bar chart of Strong acid (HCl) against Weak base (NH_3)

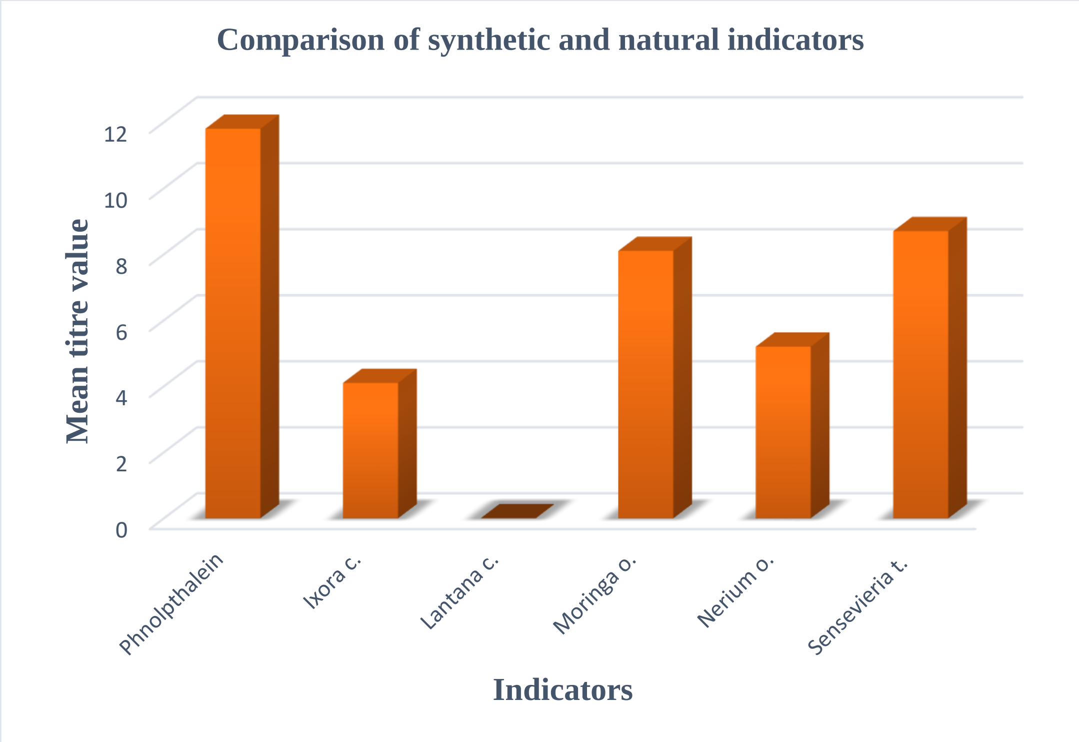

Figure 3: Titration Bar chart of Weak acid (CH_3COOH) against Strong base (KOH)

Discussion

Five different flower extracts were used in the titration, and the findings demonstrate that some of the end points achieved using natural indicators were extremely similar to those obtained using artificial indicators, as shown in table 9. For strong acid against strong base titration (HCl and KOH), the end point obtained using Moringa o. flower extract indicator is similar to that of methyl orange with titre mean values of 8.13 ± 0.1530 and the end point obtained using sensevieria t. flower extract indicator is similar to that of phenolphthalein with titre mean values of 11.70 ± 0.100. Hence the flower extract of *Moringa o.* and *sensevieria t.* can be used to replace Methyl orange and phenolphthalein respectively for strong acid against strong base titrations. For strong acid against weak base titration (HCL and NH_3), the end point obtained using *ixora c., Moringa o. and Sensevieria t.* flower extract indicator corresponds to that of methyl orange with titre mean values of 5.58 ± 0.100, 5.87±0.153 and 5.40±0.100 respectively. Hence the flower extracts of *ixora c*., *Moringa o.* and *sensevieria t.* can be used in place of Methyl orange for strong acid against weak base titrations. For weak acid against strong base titration (CH_3COOH and KOH), the end point obtained using *Moringa o., Nerium o. and Sensevieria t.* flower extract indicator matched that of Phenolphthalein with titre mean values of 6.10± 0.100, 6.03±0.123 and 6.57±0.152 respectively. Hence the flower extract of *Moringa o*., *Nerium o* and *sensevieria t*. can be used to replace Phenolphthalein for weak acid against strong base titrations.

CONCLUSION

As an acid-base indicator, pigments were isolated from the flowers of Ixora c., Lantana c., Moringa o., Nerium o., and Senvieria t. Based on the results of this study, it can be concluded that there was no discernible difference between the mean titre values of methyl orange and Ixora c. flower extract in strong acid against weak base. Methyl orange can be replaced with Ixora c. flower extract when a strong acid is being used against a weak base. For strong acid against strong base, strong acid against weak base, and weak acid against strong base titrations, respectively, moringa o. flower extract can be used as a substitute for methyl orange and phenolphthalein. An alternative to phenolphthalein in weak acid versus strong base tiration is nerium o. flower extract. In titrations of strong acid against weak base and strong acid against strong base, sensevieria t. flower extract can be used in place of phenolphthalein and methyl orange, respectively. The lack of a noticeable reaction in the acid-base titration of lantana c. flower extract may be caused by the solvent used, which may not be ideal for extracting the flavonoid and anthocyanin present in it.

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