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An Investigation of *Antigonon leptopus* Hook. & Arn. as Natural pH Indicator in Acid-Base Titrations

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Abstract: ***Synthetic pH indicators are usually employed in acid-base titrimetric analysis to identify the end point. However, there are a number of significant challenges with synthetic pH indicators, such as the potential toxicity, carcinogenicity, and non-biodegradability, which raises issues with the environment and public health. The present study aimed to substitute natural indicators for synthetic ones. This study deals with a search of plants as a natural source serving as eco-friendly acid-base (pH) indicators. Strong acid (SA) vs. strong base (SB) and strong acid (SA) vs. weak base (WB) titrations were used to assess potential of the three different extracts (distilled water, boiled water and ethanol) of Antigonon leptopus flower. Natural indicators exhibit promising results and a sharp and intense colour change near the neutralization point when titrated against available synthetic acid-base indicators such as methyl orange and phenolphthalein. Since these sources readily available, non-toxic, simple to extract, environmentally friendly, and accurate in many kinds of acid-base titrations, these natural indicators may be a great substitute for synthetic ones.***

Keywords: Antigonon leptopus flower, Distilled water, boiled water, ethanol, natural and synthetic indicators

1. Introduction

God created flowers as a wonder of nature for the world. Natural plant pigments and dyes are rich in colour and can change colour in response to pH changes [13]. The woody, invasive liana *Antigonon leptopus* Hook. & Arn., is a member of the family Polygonaceae. With the help of slender tendrils, Coral Vine is a large, extensive, rapidly growing climber that can reach heights of 40 feet or more. Leaves are dark green, heart-shaped to arrowhead-shaped, to 5 inches long. Probably the heart-shaped leaves and the delicate pink flowers led to its Mexican name, cadena de amor or "chain of love". It produces edible tubers. The actual flowers are tiny, but the sepals are larger and provide the brilliant colours that range from white to rose-pink to deep coral flowered varieties [2]. The ethanol and chloroform extracts of *Antigonon leptopus* flowers demonstrated strong antibacterial activity against *Salmonella typhi, Bacillus subtilis*, and *Bacillus peritolis* as well as the presence of volatile oils, carboxylic acids, terpenes, carbohydrates, and glycosides as chemical constituents [1]. The plant is reported to possess various bioactivities such as antimicrobial, antioxidant, hepatoprotective, analgesic, anti-inflammatory, cytotoxic and anti-diabetic activities [20].

In acid-base titrations, indicators can be dyes or pigments that have been extracted from a variety of sources, such as plants, fungi, and algae [21],[22] and used to determine the endpoint (equivalence point) of any titration [12]. Commonly used indicators for acid-base titrations are synthetic. In addition to being extremely expensive, many synthetic indicators have harmful side effects and pollute the environment [14], [16]. Finding alternate sources of indicators with natural origins has thus become imperative. These natural indicators are intended to be used as a cost-effective, environmentally friendly, and readily available substitute for synthetic indicators. Thus, the present study attempted to find a substitute to the presently existing synthetic indicators by using natural pigments from *Antigonon leptopus* flower extract.
the labels "(a)" and "(b)".

2. Materials and Methods

2.1 Materials

Fresh floral petals of *Antigonon leptopus* flowers were collected from different local area of Amravati and extracted in order to investigate their inherent indication qualities.

Figure 1: *Antigono leptopus* -Habit

Figure 2: *Antigonon leptopus flower powder*

Figure 3: Freshly prepared extracts (pigment) from *Antigonon leptopus* Flowers

2.2 Methods:

a) Extraction of pigments:
Various methods were employed to prepare the extracts used in the studies.

Distilled Water Extract (Overnight soaking):
10g of petals were soaked in distilled water overnight and then filtered after 24h. The filtrate was used as a pH indicator [9].

Boiled Water Extract:
10g of petals were boiled in 100 mL of distilled water for 20 minutes. After cooling, the samples were filtered. The filtrate is used as a pH indicator.

Ethanol Extract:
10g of petals were soaked in ethanol overnight and then filtered after 24h. The filtrate was used as a pH indicator.

b) Reaction of the Extracts with Acids and Bases:
Strong acid (HCl), Strong base (NaOH), Weak acid (CH3COOH), and Weak base (NH4OH) were all made into 0.1 N solutions. To assess the colour change, samples of each extracted substance were introduced to various bases and acids. The colour change in plant extracts at various pH conditions was noted and observed [17], [18].

c) Acid-Base Titrations:
The performance of plant extracts was compared to that of the standard chemical indicators (phenolphthalein and methyl orange) using acid-base titrations. A phenolphthalein indicator was used to titrate 0.1 N HCl against NaOH, while methyl orange was used to titrate 0.1 N HCl against NH4OH and the various plant extracts as indicators [19].

3. Results and Discussion

The present study screened the flower extracts of *Antigonon leptopus* for their potential use as an acid-base indicator in acid-base titrations. The screening results were compared to those of standard indicators such as methyl orange and phenolphthalein for strong acid-strong bases (HCl and NaOH) and strong acid-weak bases (HCl and NH_4OH). The equivalency points that the flower extract produced for each titration matched those that were determined by standard indicators.

3.1 Extraction of pigments and Determination of pH of the plant extracts:

The pigments were extracted from *Antigonon* flower using various methods of extraction and the results showed that the water extract produced a pink colour, the boiled water extract produced a dark pink colour, and the ethanol extract produced a dark pink colour (Table 1, Fig. 1,2,3). A pH meter was used to measure the pH of these pure extracts after they were prepared. According to the pH readings, the *Antigonon* flower has a pH between 5 and 6, indicating that the extracts are naturally acidic (Table 1).

Table 1: pH of the plant extracts

Sr. No.	Extract *(Antigonon* flower)	Colour	pH
1.	Distilled Water (Overnight soaking)	Pink	6.4
2.	Boiled water extract	Dark Pink	5.7
3.	Ethanol (Overnight soaking)	Dark Pink	6.8

3.2 Investigation of indicator colour change with pH:

To notice the colour shift of the plant pigment with a change in pH, five solutions of varying pH were prepared and 1 ml of the extract was added, and the colour change was recorded (Table 2 and 3) [10].

Table 2: Solutions and their pH

Sr No.	Solutions (0.1N)	P^H
1	HCl	2.00
2	CH_3COOH	3.23
3	$C_2H_2O_4$	4.14
4	NaOH	10.00
5	NH_4OH	11.63

Table 3: Colour change *of Antigonon leptopus* flowers extracts with pH

No	Extracts	Observation	HCl 2 .00 (pH)	CH_3COOH 3.23 (pH)	$C_2H_2O_4$ 4.14 (pH)	NaOH 10.00 (pH)	NH_4OH 11.63 (pH)
1.	Distilled Water	Colour change	Dark pink	Light pink	Dark pink	Lemon yellow	Golden yellow
2.	Boiled Water	Colour change	Dark pink	Light pink	Light yellow	Cream	Dark yellow
3.	Ethanol	Colour change	Dark pink	Pink	Pink	Lemon yellow	Golden yellow

3.3 Titration using natural indicators:

To assess the dyes potential usage as indicators in acid-base titration, several titrations were carried out. The end points of the acid-base titrations that were demonstrated using two to three drops of the colours as well as commercially available indicators are reported in Table--The titration results revealed that the end points of the titration of strong acid against strong base (HCl Vs. NaOH) and strong acid against weak base (HCl Vs. NH_4OH) using the natural indicator either coincided with or nearly reached the end point determined by the standard indicator phenolphthalein, and the end point gives sharp colour change. The result exhibited that in Strong Acid vs. Strong Base (HCl / NaOH) all the extracts (water, boiled, ethanol) of *Antigonon* flower exhibited mean titration pH around 8.2–8.4, with colour transitions from yellow/cream to colourless which closely matches phenolphthalein's performance. In strong acid vs. weak base (HCL/NH_4OH)

reaction *Antigonon* water and boiled extracts endpoint was well-aligned with HCl/NH_4OH equivalence point, whereas ethanol extract endpoint with pH 6.2, slightly higher but still closer to the true endpoint than methyl orange (Table 4). Therefore, it can be said that *Antigonon* flower extract can be utilized for acid-base titration in place of commercially available indicators. Since, these extracts show colour change in response to a change in pH, these can be used to identify acids and bases [10].

Table 4: Colour change & pH of the solutions at the end point of titration with *Antigonon* flower extracts as well as synthetic indicators

Titrant/ Titrate	Indicator	Colour change at the End point	Mean of Titrations	Ph
HCl/NaOH	Phenolphthalein	Colourless to Pink	8.0	8.3
	Antigonon Flower (Water)	Lemon yellow to Colourless	8.3	8.3
	Antigonon Flower (Boiled)	Cream to Colourless	8.3	8.3
	Antigonon Flower (Ethanol)	Lemon yellow to Colourless	8.4	8.2
HCl/NH_4OH	Methyl Orange	Red to Yellow	8.4	4.1
	Antigonon Flower (Water)	Golden yellow to Colourless	8.4	5.1
	Antigonon Flower (Boiled)	Dark yellow to colourless	7.1	5.4
	Antigonon Flower (Ethanol)	Golden Yellow to colourless	9.1	6.2

D.W.- Distilled water; Ph Ind.- Phenolphthalein Indicator, M.O. Ind.- Methyl orange Indicator

For all titrations, the equivalence points attained by the flower extract matched those that were determined by standard indicators.

For acid-base titrimetric analysis, all available data demonstrated that naturally produced indicators are just as significant and effective as standard and other chemically synthesized indicators. Additionally, the indicator made from flower extract can successfully replace the chemically synthesized indicator. All coloured flowers contain the flavonoid anthocyanin, which may be the cause of their colour. Therefore, the flower we select for our natural indicator must be coloured; this indicates that it contains anthocyanin and other flavonoids that give it the ability to change colour in a variety of acid & bases [3],[4]. The potential of flower extract of an *Erythrina varigata, Euphorbia mili* and *Nelumbo nucifera* in acid base indicator coincides with the equivalence points obtained by standard indicators [7]; various plants extracts are used as acid base indicator such as *Rosa sinensis, Dahlia pinnata* and *Butea monosperma* etc. recommend that the dye and extract from plants can be used as alternative to various synthetic pH indicator during titrimetric analysis as an indicator in all types of acid base titrations because of its economy, simplicity and wild availability. Similarly *Tagetes Erecta, Impatiens Balsamina, Tecoma stans* and *Rosa* double delight flowers gave the positive results at neutralization [15], Seven plant extracts from Violet cabbage, *Beetroot*, Red *Hibiscus*, *Turmeric* powder, Red rose flower, *Henna* Leaves and pink *Mirabilis Jalapa* flower were found to perform well in strong acid-strong base titrations [10], *Areca catechu* seed when assessed as a natural indicator in comparison to a synthetic indicator like phenolphthalein, was found to be similar [8]. Aqueous extract of each flower from *Dendrobium Sp.* & *Hippeastrum puniceum* can be used as a replacement [6], extracts of *Heena, Hibiscus, Turmeric* can serve as suitable indicators in acid-base titration involving a strong acid and a strong base [9], it indicated that all the natural pigments can be used as a substitute to synthetic indicators.

4. Conclusion

The synthetic indicators are very hazardous to health and cause pollution; therefore to solve this problem floral extract has been selected as a source of indicator for acid-base titration. A range of acid-base titrations has been performed to assess the accuracy of the results. The results were obtained by all *Antigonon* extracts match phenolphthalein well in both endpoint pH and distinct colour change best with water and boiled water extract, making them preferable natural alternatives and superior to methyl orange for detecting NH_4OH titrations as well. The findings, therefore, indicated an alternative way of equipping the laboratory with practical instructional material (indicators) using plants that are around or within the environment.

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