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Research article

Extraction of natural dye from waste flowers of Aster (*Aster chinensis)* and studying its potential application as pH indicator

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Abstract

Disposal of synthetic dyes has become a cause of concern due to its deleterious effects on environment and living systems. Due to this, efforts are now being made to replace these harmful dyes with natural dyes obtained from plant sources. Our study was aimed to extract natural dye from waste flowers of *Aster chinensis* and further test its application as pH indicator in acid-base titrations. Dark and light pink hued petals of waste aster flowers were used. Their applicability as natural indicators were studied in various acid-base titrations such as strong base-strong acid, strong base-weak acid, weak acid-strong base, weak base-strong acid and strong acid-weak base. These titrations were also performed separately using standard synthetic indicators such as phenolphthalein and methyl red. The end points obtained using natural and synthetic indicators were compared. Natural dyes extracted from dark and light pink coloured aster flowers produced visually distinct colour change at the end points of the studied titrations. These end point values were in correspondence with those obtained from standard pH indicators for the respective titrations. The present study displayed a practical procedure for obtaining suitable extract from waste flowers of aster that can be further used as an accurate, economic and environment friendly replacement for synthetic pH indicators in titrimetric analysis. Additional studies to test other industrial applications of these aster extracts are warranted.

Introduction

Environmental pollution has become a major concern due to its deleterious effect on climate and living habitat. Though industrialization has led to the progress of mankind, it has also affected the environment due to use of chemicals and improper waste management [1-2]. Synthetic dyes are widely used in industries like textile, leather and also as commercial indicators. The production and use of these dyes have been reported to have toxic effects on the environment and living habitat [3-5]. It has also been reported that the estimated use of synthetic dyes is around 10,000,000 tonnes per annum [6].

In view of the ever-increasing health hazards due to synthetic dyes, research studies are now focusing on finding alternate methods for production of cheaper, environment-friendly and non-toxic dyes [7-8]. One such alternative, which is being explored, is the extraction of natural dyes from plant sources. However, due to limitations faced in extracting these natural dyes, synthetic dyes are still preferred as colouring agents [9]. To curb this setback, research is being carried out to device a suitable, cost-effective methodology for extraction of natural dyes. In the past years, several studies have been performed to isolate extracts from various plant sources. These plant extracts have been further screened to evaluate their applications as dyes for cotton and other textile fabrics [10-13], mycological stains [14], leather dyes [5] and pH indicators [15-18].Commercially available synthetic dyes such as phenolphthalein, phenol red, methyl red, bromophenol blue, thymol blue etc. are commonly preferred as pH indicators in acid-base titrations. pH indicators are molecules that change colour due to change in pH in a chemical reaction. Despite the availability of automated instruments, conventional analytical technique such as titrimetry is still considered a reliable method in many applications [18]. Titrimetry works on the principle of determining the end point of an acid-base reaction when the solution forms salt and water [18]. The synthetic pH indicators are weak organic acids or bases that accept or donate electrons and undergo colour-change in a titrimetric reaction based on their acidic or alkaline properties. These indicators have been reported to have harmful effects on humans such as gastrointestinal problems, pulmonary edema, hypoglycemia, allergy, skin irritation and necrosis [18-20]. Due to this, use of natural pH indicators is gaining importance as a potential replacement for these chemical indicators. Recent studies have successfully extracted natural dyes from fresh

flowers such as rose (*Rosa setigera*), hibiscus (*Hibiscus rosa-sinensis*), *Ixora coccinea*, dahalia and tested them as pH indicators [18, 21-23].

India has a rich cultural and religious heritage wherein; flowers such as marigold, aster and roses are widely used in various ceremonies. As a result, floral waste is generated in large quantities and dumped into water bodies or improperly disposed [24]. This leads to breeding of harmful microbes since flowers have high carbon/nitrogen ratio and moisture content [25]. Surveys have reported that approximately 1450 tonnes of flowers are disposed as waste from temples after they are presented as offerings all over India [26]. Hence, utilization of these floral wastes in a productive way is warranted to avoid harmful effects due to waste flower pollution. Previous research studies have revealed useful applications of waste flowers of marigold and saffron in dyeing textile fabrics and leather [5, 27-29]. However, to date, application of waste aster flower extract as pH indicator has not been explored. In view of this current scenario, our study aimed to focus on the extraction of valuable natural dye from waste aster flowers and further test its application as a substitute for synthetic pH indicators.

Materials and methods

Sample collection and preparation

Two varieties of Aster flowers with light pink and dark pink petals were obtained from local markets of Mumbai. The taxonomic authentication of the collected flowers was performed at the Blatter Herbarium, St. Xavier's College, Mumbai. The flowers were identified as cultivar of *Callistephus chinensis* (L.) also known as *Aster chinensis* (L.).

These flowers were stored and used after 3 days. The rationale behind this treatment was that flowers used in temples or households usually get discarded within this time interval. The waste aster petals were then plucked. Sample preparation was done by separating these petals on the basis of their colour onto two different trays at room temperature. These petals were then subjected to Soxhlet extraction.

Soxhlet extraction

Samples were extracted by Soxhlet extraction method. Separate Soxhlet extraction procedures of 7 g dark and light hued petals were carried out for 6 hours with cycle duration of 30 minutes using 50% ethanol as the solvent. Two separate flower petal extracts were obtained, *viz.* one from light hued petals and other from dark hued petals. These extracts were dried at 75°C in an oven in separate petri dishes for 2 days. They were later preserved in closed containers and stored for future use. For further analysis, these petal extracts were weighed and diluted with distilled water to make a concentration of 1 mg/ml.

Titration experiments using waste flower extract as pH indicator

The extracts were tested to ascertain their application as pH indicators. Five types of neutralization titrations were performed *viz.* strong base (1N NaOH) against strong acid (1N HCl), strong base (1N NaOH) against weak acid (1N CH_3COOH), weak acid (1N CH_3COOH) against strong base (1N NaOH), weak base (1N NH_4OH) against strong acid (1N HCl) and strong acid (1N HCl) against weak base (1N NH_4OH). Each titration was repeated 3 times to validate the end-point readings. For each neutralization titration, 5 ml of titrand was taken in a flask followed by addition of 40 µl of dark or light petal extract as the indicator.

Similar titration experiments were repeated using synthetic indicators. For this, 2-3 drops of phenolphthalein indicator were used in strong base against strong acid, strong base against weak acid and weak acid against strong base titrations. On the other hand, weak base against strong acid and strong acid against weak base titrations were performed using methyl red indicator. The end points obtained with our extracted aster petal indicators and standard synthetic indicators were compared and analyzed.

Results & discussion

The main focus of the current study was to explore the possibility of reusing waste aster flowers in a constructive way and testing their use as natural pH indicators. The aster flower extract methodology reported in the current study was simple and cost effective. The property of aster flower extracts as pH indicators was screened based on their efficiency in detecting neutralization reactions. End points obtained for various combinations of titrants and titrands by using aster petal extracts as indicators were compared to those obtained after using phenolphthalein and methyl red pH indicators. The screening results of these titrations have been summarized in Table 1.

As shown in the table, extracts of both dark pink and light pink hued petals yielded similar end point readings. Furthermore, these waste flower petal extracts displayed end point values that were in concordance with the end points obtained from titrations with phenolphthalein and methyl red indicators. This highlights the usefulness of these waste aster petal extracts as a suitable pH indicator. The Material Safety Data Sheet (MSDS) of phenolphthalein has reported its harmful effects such as skin irritation, eye irritation, irritation of the digestive tract, respiratory tract problem, blood pressure increase and other vascular effects. Research reports have also highlighted carcinogenic effects of phenolphthalein dye [30-31]. Methyl red has been reported to cause carcinogenic effects, eye and skin sensitization and digestive tract irritation [32]. Taking these factors into consideration, natural extracts obtained from waste aster

flowers can prove to be an appropriate replacement for artificial dyes as they are harmless and easily obtainable alternatives.

Previous studies have reported successful use of waste flowers of marigold, rose and saffron in dyeing cotton fabrics and leather [5, 28-29]. However, as mentioned earlier, the use of waste aster flower as possible pH indicator has not been explored. The current study is thus the first study, to the best of our knowledge, to highlight the same.

Recent reports on fresh aster flower extracts *(Callistephus chinensis*) have revealed their potential properties as antibacterial, antioxidant and anticancerous agents [33-34]. It would be interesting to analyze whether waste aster flowers retain the same level of anti-bacterial and antioxidant properties as their fresh counterparts. Also, studies on use of waste aster petal extracts as textile dyes can be performed to assess their versatility as natural dyes. As the current study only focused on waste aster petal extracts, further work may be carried out to explore the possible use of the aster petal byproducts that remain after Soxhlet extraction procedure. These byproducts may be utilized as compost since flowers are known to have high organic content [25, 35].

Table 1. End point results in titrimetric analysis using synthetic and natural indicators.

Titrant *vs.* Titrand	Indicator	End point	Mean Titration readings ± SD
1) NaOH *vs.* HCl	Phenolphthalein	Colourless to pink	5.2 ± 0
	Dark Pink Aster petal extract	Colourless to yellow	5.2 ± 0
	Light Pink Aster petal extract	Colourless to yellow	5.2 ± 0
2) NaOH *vs.* CH_3COOH	Phenolphthalein	Colourless to pink	5.73 ± 0.05
	Dark Pink Aster petal extract	Colourless to yellow	5.73 ± 0.05
	Light Pink Aster petal extract	Colourless to yellow	5.73 ± 0.05
3) CH_3COOH *vs.* NaOH	Phenolphthalein	Pink to colourless	4.43 ± 0.05
	Dark Pink Aster petal extract	Yellow to colourless	4.5± 0
	Light Pink Aster petal extract	Yellow to colourless	4.4±0
4) NH_4OH *vs.* HCl	Methyl Red	Red to yellow	5.03 ± 0.05
	Dark Pink Aster petal extract	Colourless to yellow	5.0 ± 0
	Light Pink Aster petal extract	Colourless to yellow	5.0 ± 0
5) HCl *vs.* NH_4OH	Methyl Red	Yellow to red	5.0 ± 0
	Dark Pink Aster petal extract	Yellow to colourless	5.0 ± 0
	Light Pink Aster petal extract	Yellow to colourless	5.0 ± 0

NaOH: Sodium Hydroxide
HCl: Hydrochloric acid
CH_3COOH: Acetic acid
NH_4OH: Ammonium hydroxide
Phenolphthalein and Methyl red: Synthetic indicators
Dark pink and light pink Aster petal Extracts: Natural Indicators

Conclusion

In conclusion, the current work reported a successful methodology for obtaining useful extract from waste Aster (*Callistephus chinensis)* flowers. Additionally, this extract can be used as a suitable substitute for synthetic pH indicators such as phenolphthalein and methyl red in titrimetric analysis.

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