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Synthesis of Natural pH Indicators from Flowers and Vegetables and Their Environmental Impact

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Abstract- — Synthetic acid-base indicators, though widely used, present challenges such as toxicity, environmental hazards, and high cost. This study explores the preparation of eco-friendly pH indicator strips using natural sources including turmeric (Curcuma longa), rose (Rosa indica), beetroot (Beta vulgaris), and red cabbage (Brassica oleracea). Extracts were prepared by aqueous extraction and applied to paper strips to develop natural indicators. The prepared strips were tested on 59 household chemicals and 14 standard pH solutions (pH 1–14). The results demonstrated distinct color variations for acidic, neutral, and basic media. Red cabbage showed a wide color range comparable to universal pH paper, while turmeric, rose, and beetroot exhibited clear differentiation between acids and bases. The study confirms that natural indicators are cost-effective, biodegradable, non-toxic, and suitable alternatives to synthetic indicators for educational and analytical applications.

Keywords— Natural indicators, pH paper, Green chemistry, Turmeric, Red cabbage, Acid-base indicators.

I. INTRODUCTION

Acid-base indicators are essential tools in chemistry for determining the pH of solutions. Conventional synthetic indicators such as phenolphthalein and methyl orange are widely used but pose environmental and health concerns due to their toxicity and non-biodegradability.

Natural indicators derived from plant sources offer a sustainable alternative. Many plants contain pigments such as anthocyanins, curcumin, and betalains, which exhibit color changes with pH variation. These pigments are eco-friendly, inexpensive, and readily available.

This study focuses on the synthesis of natural pH indicator strips from commonly available flowers and vegetables and evaluates their performance in comparison with synthetic indicators.

II. MATERIALS AND METHODS

1. Plant Materials

- Turmeric (Curcuma longa)
- Rose (Rosa indica)
- Beetroot (Beta vulgaris)
- Red cabbage (Brassica oleracea)

2. Preparation of Extracts

- Plant materials were washed and cleaned
- Boiled in distilled water for ~10 minutes
- Cooled and filtered using filter paper

3. Preparation of Indicator Strips

- White paper dipped in extracts for 15 minutes
- Air-dried for 12 hours
- Cut into strips

4. Testing Procedure

Tested on:

- 59 household chemicals
- 14 standard pH solutions (1–14)
- Compared with commercial pH paper

III. RESULTS AND DISCUSSION

1. Prepared Natural Indicator Strips

Figure 1: Natural pH indicator strips from plant extracts (Turmeric, rose, beetroot, red cabbage)

2. Color Response of Indicators

Table 1: Color Change of Natural Indicators

Indicator	Acidic	Neutral	Basic
Turmeric	Yellow	No change	Red
Rose	Pink	Light purple	Green/Blue
Beetroot	Pink	Light pink	Purple
Red Cabbage	Red/Pink	Purple	Blue/Green/Yellow

3. Analysis of Household Chemicals

Table 2: Classification of Tested Samples

Category	Examples	pH Range
Strong Acids	Harpic, battery acid	1–2
Weak Acids	Lemon, vinegar	3–6
Neutral	Water, salt	~7
Weak Bases	Toothpaste, tea	8–10
Strong Bases	Baking soda, bleach	11–14

4. Indicator Performance

- Turmeric: Clear distinction (acid vs base)
- Rose & Beetroot: Moderate range
- Red cabbage: Wide color spectrum (best performance)

5. Comparative Analysis

Table 3: Natural vs Synthetic Indicators

Parameter	Synthetic Indicators	Natural Indicators
Cost	High	Low
Toxicity	Present	None
Availability	Limited	Easily available
Environmental Impact	Harmful	Eco-friendly

6. Mechanism of Color Change

- Anthocyanins → wide pH range
- Curcumin → basic sensitivity
- Betalains → moderate response

7. Educational and Environmental Impact

- Useful for home laboratories (COVID context)
- Promotes green chemistry awareness
- Reduces chemical waste

IV. CONCLUSIONS

The study successfully demonstrates the preparation of natural pH indicator strips from plant sources. These indicators show comparable performance to synthetic indicators, with red cabbage providing the most accurate pH range. Natural indicators are cost-effective, safe, biodegradable, and environmentally friendly. They are particularly useful for educational purposes and sustainable laboratory practices.

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