

## **EVALUATION OF HIBISCUS AND ROSE FLOWER EXTRACTS AS ECO-FRIENDLY NATURAL PH INDICATORS FOR ACID-BASE TITRIMETRIC ANALYSIS**

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**Abstract:** The widespread use of synthetic acid–base indicators in chemical laboratories has raised concerns regarding toxicity, environmental pollution, and disposal hazards. In recent years, increasing emphasis on green chemistry has encouraged researchers to identify sustainable alternatives derived from natural sources. In the present work, aqueous extracts of *Hibiscus rosa-sinensis* and *Rosa rubiginosa* flowers were investigated as

eco-friendly natural pH indicators for acid–base titrimetric analysis. Flower extracts were prepared using hot water extraction methods and characterized through acid–base titration and UV–Visible spectroscopic analysis. The prepared extracts showed sharp color transitions in acidic and alkaline media. Hibiscus extract exhibited a pink coloration in acidic medium and pale yellow coloration in alkaline medium, whereas rose extract showed red to greenish transitions. UV–Visible spectroscopy revealed maximum absorbance at 580 nm due to anthocyanin pigments responsible for pH sensitivity. Experimental results demonstrated endpoint detection comparable to synthetic indicators such as phenolphthalein and methyl red. Furthermore, natural indicators were found to be inexpensive, biodegradable, non-toxic, and environmentally friendly. The findings indicate that flower-based natural indicators can effectively replace synthetic indicators in laboratory analysis and educational chemistry applications.

**Keywords:** Natural indicators, *Hibiscus rosa-sinensis*, Rose extract, Anthocyanins, Acid–base titration, UV–Vis spectroscopy, Green chemistry.

### **1. Introduction**

Indicators are chemical substances that undergo visible color changes depending on the pH of the medium and are widely used in acid–base titration for endpoint detection. Synthetic indicators such as phenolphthalein, methyl orange, and methyl red are extensively used in analytical laboratories due to their sensitivity and ease of use.

However, synthetic indicators are often associated with environmental hazards, toxicity, and disposal problems [1]. The increasing awareness regarding sustainable chemistry and environmental protection has encouraged researchers to identify eco-friendly alternatives to synthetic indicators. Natural indicators derived from flowers, fruits, leaves, and roots have gained significant attention because they are biodegradable, cost-effective, and readily available [2]. Many plant pigments such as anthocyanins, flavonoids, carotenoids, and betalains exhibit pH-sensitive color changes, making them suitable for analytical applications [3]. Anthocyanins are water-soluble pigments responsible for red, blue, and purple coloration in flowers and fruits. These pigments undergo structural transformations under acidic and alkaline conditions, resulting in distinct color variations. Hibiscus and rose flowers are rich in anthocyanin pigments and therefore possess excellent pH-sensitive properties [4]. Several studies have investigated the use of flower extracts as natural indicators. Sharma et al. reported successful application of flower pigments in acid–base titration [5]. Rahmawati et al. evaluated *Torenia* flower extract and observed endpoint detection comparable to commercial indicators [6]. Wiyantoko and Astuti

demonstrated the effectiveness of butterfly pea flower extract as a natural indicator [7]. The present work focuses on evaluating hibiscus and rose flower extracts as natural acid–base indicators through extraction yield analysis, titration experiments, and UV–Visible spectroscopic characterization.

## **2. Literature Review**

Natural indicators have been used traditionally for several decades in chemistry education and analytical laboratories. Previous research indicates that naturally occurring pigments provide excellent color variation under different pH conditions. Pathan and Farooqui reviewed analytical applications of natural plant extracts and concluded that anthocyanin-rich flowers are suitable for acid–base titration [2]. Vankar and Bajpai studied rose anthocyanins and reported stable color transitions under acidic and alkaline conditions [4]. Bhuvaneshwari et al. investigated beetroot extracts and confirmed their effectiveness as natural indicators because of betalain pigments [3]. Similarly, Sharma et al. reported that flower-based indicators produce sharp endpoints and can replace synthetic indicators in educational laboratories [5]. Recent studies have expanded the scope of natural indicators. Rahmawati et al. investigated *Torenia fournieri* flower extract and found high endpoint accuracy in titration experiments [6]. Ghurde and Aswar studied *Antigonon leptopus* flower extract and confirmed that natural indicators exhibit low toxicity and high sensitivity [8]. Despite extensive studies, there is still a need for comparative analysis involving extraction efficiency, UV–Visible spectroscopy, and statistical validation. Therefore, the present work aims to provide detailed evaluation of hibiscus and rose flower extracts.

## **3. Experimental Methodology**

Fresh hibiscus flowers and rose petals were collected and washed thoroughly with distilled water. The petals were dried at room temperature for 24 hours and then crushed using a mortar and pestle. Approximately 20 g of dried flower material was mixed with 60 mL distilled water and heated on a hot plate for 10 minutes to extract the pigments. The mixtures were cooled and filtered using filter paper to obtain clear colored extracts. Standard 0.1 N sodium hydroxide and 0.1 N nitric acid solutions were prepared using distilled water. Acid–base titration experiments were performed using the flower extracts as indicators. Each titration experiment was repeated three times to improve reliability and repeatability. The pH values of the solutions were measured using a calibrated digital pH meter. UV–Visible spectroscopy was performed over a wavelength range of 400–700 nm to determine the maximum absorbance wavelength of the extracts.

## **4. Results and Discussion**

The extraction yield obtained from hibiscus flowers was higher than that obtained from rose petals. The higher yield is attributed to the greater concentration of anthocyanin pigments in hibiscus flowers. Distinct color changes were observed in acidic and alkaline media. Figure 1 indicate Extraction Process of Natural Indicator

Hibiscus extract changed from pink in acidic medium to pale yellow in alkaline medium, while rose extract showed red to greenish coloration. Table 1 shows extraction Yield of Natural Indicators

The UV–Visible absorption spectrum revealed maximum absorbance at 580 nm, confirming the presence of anthocyanin pigments. Anthocyanins undergo structural modifications due to protonation and deprotonation reactions under varying pH conditions, leading to visible color changes. The titration endpoints obtained using natural indicators were comparable to those obtained using synthetic indicators such as phenolphthalein and methyl red. Table 2 Shows Color Change Behavior of Hibiscus Extract

These findings are consistent with previous studies involving natural flower indicators [5–8]. Natural indicators provide several advantages over synthetic indicators. They are biodegradable, inexpensive, easy

to prepare, and environmentally friendly. Figure 2 shows UV–Visible Absorption Spectrum.

Therefore, they can serve as suitable substitutes for synthetic indicators in chemistry laboratories and educational institutions.

**Table 1. Extraction Yield of Natural Indicators**

Plant Extract	Mass of Extract (mg)	Yield (%)
Hibiscus	290	1.45
Rose	220	1.10

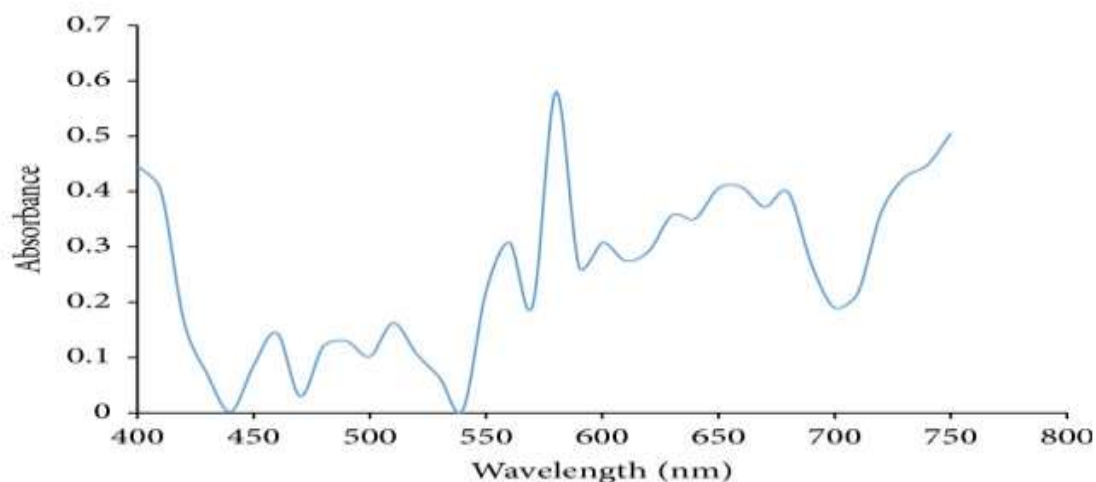
**Table 2. Color Change Behavior of Hibiscus Extract**

Medium	Observation
Acidic medium (HNO <sub>3</sub> )	Pink
Basic medium (NaOH)	Pale Yellow

**Figure 1. Extraction Process of Natural Indicator**

- Fresh Flowers
- 
- Washing and Drying
- 
- Grinding of Petals
- 
- Heating with Distilled Water
- 
- Filtration
- 
- Colored Extract Obtained

**Figure 2. UV–Visible Absorption Spectrum**



## **5. Advantages of Natural Indicators**

Natural indicators are environmentally safe and biodegradable because they are obtained from plant materials. Unlike synthetic indicators, they do not produce harmful chemical residues. The preparation of natural indicators is simple and inexpensive. Raw materials such as flowers and leaves are easily available in local environments, making them highly economical. Natural indicators are non-toxic and safe for laboratory users, especially in educational institutions. They also support the principles of green chemistry and sustainable analytical practices. Because of these advantages, natural indicators are gaining increasing attention in analytical chemistry research and chemistry education.

## **6. Conclusion**

The present study demonstrated that hibiscus and rose flower extracts can effectively function as natural acid–base indicators. Distinct color transitions were observed in acidic and alkaline media, and UV–Visible spectroscopic analysis confirmed the presence of anthocyanin pigments responsible for pH-sensitive color changes. The titration results obtained using flower extracts were comparable to those obtained using synthetic indicators such as phenolphthalein and methyl red. Furthermore, the natural indicators were biodegradable, economical, non-toxic, and eco-friendly. Therefore, hibiscus and rose flower extracts can serve as sustainable substitutes for synthetic indicators in educational laboratories and analytical chemistry applications. Future studies may focus on stability enhancement, shelf-life evaluation, and industrial-scale applications of natural indicators.

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