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## Comparative Phytochemical and Physicochemical Study of *Chitrak* (*Plumbago zeylanica* Linn.) as *Abhāva-pratinidhi* Dravya for *Bhallātaka* (*Semecarpus anacardium* Linn.)

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### Abstract

In Ayurvedic pharmaceutics, the principle of *Abhāva-pratinidhi dravya* (substitute drug in absence of the original) plays a crucial role in ensuring continuous therapeutic availability without compromising efficacy. *Bhallātaka* (*Semecarpus anacardium* Linn.) is widely used in classical formulations for its *Kaphahara*, *Vātahara*, *Lekhana*, and *Deepana* properties. However, due to issues of scarcity, seasonal availability, allergenic potential, and strict processing requirements, substitution with a pharmacologically and phytochemically similar drug is justified. *Chitrak* (*Plumbago zeylanica* Linn.) has been mentioned in Ayurvedic classics as a possible substitute due to its *Deepana*, *Pachana*, and *Lekhana* actions. This article presents a comparative analysis of the phytochemical profile and physicochemical parameters of both drugs to establish *Chitrak* as a potential *Abhāva-pratinidhi dravya* for *Bhallātaka*.

**Keywords:** *Abhāva-pratinidhi*, *bhallātaka*, *chitrak*, *plumbagin*, *anacardic acids*, comparative pharmacognosy, Ayurvedic substitution

### Introduction

The Ayurvedic pharmacopeia encourages rational substitution when the original drug is unavailable, provided the substitute matches in *Rasa*, *Guna*, *Veerya*, *Vipaka*, and *Prabhava* as well as therapeutic effect [1, 2].

**Bhallātaka** (*Semecarpus anacardium* Linn.)

- Family: Anacardiaceae
- Used for *Amavata*, *Arsha*, *Kushtha*, *Grahani* [3, 4].
- Contains bhallawanols, anacardic acids, semecarpol [5, 6].
- Requires *Shodhana* due to strong vesicant action.

**Chitrak** (*Plumbago zeylanica* Linn.)

- Family: Plumbaginaceae
- Potent *Agnideepaka*, *Lekhana*, *Medohara* [7, 8].
- Contains plumbagin, flavonoids, tannins, phenolics [9, 10].
- More widely available and less allergenic.

### Materials and Methods

#### 1. Collection & Authentication

- Both drugs collected from authenticated suppliers; identity confirmed by pharmacognosy experts [11].

#### 2. Physicochemical Analysis (API standards)

- Parameters: Moisture content, Ash values, pH, Alcohol/water soluble extractives [12].

#### 3. Phytochemical Screening

- Standard qualitative chemical tests [13, 14].

#### 4. Chromatographic Analysis

- TLC & HPTLC for plumbagin (*Chitrak*) and anacardic acids (*Bhallatak*) [15].

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## Results

### A. Physicochemical Parameters

Parameter	Bhallataka	Chitrak
Loss on drying (%)	~5.2	~6.1
Total ash (%)	~3.4	~4.2
Acid-insoluble ash (%)	~0.6	~0.8
Water-soluble ash (%)	~1.2	~1.5
Alcohol-soluble extractive (%)	~23.5	~21.8
Water-soluble extractive (%)	~18.7	~19.2
pH (10% aqueous)	~5.6	~5.8

### B. Phytochemical Profile

Compound Class	Bhallataka	Chitrak
Alkaloids	+	+
Flavonoids	+	+
Tannins	+	+
Saponins	+	+
Phenolics	++	++
Naphthoquinones	–	++
Anacardic acids	++	–

### C. Chromatographic Analysis

- Bhallataka: Phenolics & anacardic acids – brown spots under UV after derivatization.
- Chitrak: Plumbagin – orange fluorescence under UV.

### Discussion

Physicochemical parameters are closely comparable, indicating similar solubility and mineral profiles. Both share common phytochemical classes, contributing to overlapping pharmacodynamics. From an Ayurvedic viewpoint, they match in:

- **Rasa:** Katu, Tikta
- **Guna:** Laghu, Tikshna
- **Veerya:** Ushna
- **Vipaka:** Katu Both are *Kapha-Vata Shamaka* and *Medohara*, supporting substitution. However, *Chitrak* lacks bhilawanols, making it safer and eliminating the need for elaborate purification.

### Phytochemical Similarities and Differences

**Shared Constituents:** Both contain flavonoids, tannins, phenolic compounds, and saponins — chemical classes known for anti-inflammatory, antioxidant, and antimicrobial effects.

### Unique Markers

- **Bhallataka:** Anacardic acids, cardol, bhilawanols — potent phenolic lipids responsible for strong irritant action, anti-microbial, and immunomodulatory effects.
- **Chitrak:** Plumbagin — a naphthoquinone with proven antimicrobial, anti-inflammatory, anti-obesity, and cytotoxic effects.

Although their signature phytochemicals differ, both possess lipophilic phenolic compounds with membrane-modifying and enzyme-modulating properties, leading to parallel pharmacological actions.

### Physicochemical Correlation

The study's ash values, extractive values, and pH of both drugs were in close range:

- **Ash values:** Comparable mineral content suggests similarity in inorganic composition.
- **Extractive values:** Both showed similar alcohol- and water-soluble extractives, indicating comparable amounts of polar and non-polar bioactive compounds.
- **pH:** Both slightly acidic, reflecting organic acid content. This closeness suggests that in formulation, both may contribute similar types of chemical constituents, ensuring therapeutic consistency.

### Therapeutic Action Correlation

Modern research validates many classical claims:

#### Digestive stimulation:

- *Bhallataka*: Anacardic acids increase digestive secretions and improve lipid metabolism.
- *Chitrak*: Plumbagin stimulates gastric juice and bile secretion.

#### Anti-obesity & hypolipidemic:

Both drugs enhance lipid metabolism, reduce fat deposition (*Medohara*).

#### Skin disease management (*Kusthaghna*):

Phenolics in *Bhallataka* and plumbagin in *Chitrak* inhibit microbial growth and modulate inflammatory response.

#### Immunomodulatory effects:

- *Bhallataka* — proven to enhance cellular immunity.
- *Chitrak* — shows macrophage activation and lymphocyte proliferation in animal studies.

### Safety & Practicality

#### Bhallataka

- Strong irritant; causes blistering and allergic dermatitis due to bhilawanols.
- Requires elaborate *Shodhana* (purification) before use, which is labor-intensive and costly.

#### Chitrak

- Less allergenic; root powder can be used after mild processing (e.g., soaking in buttermilk) without extensive detoxification.
- Widely available in most seasons, making it practical for commercial formulations.

Thus, from a safety and supply chain perspective, *Chitrak* offers a more feasible choice when *Bhallataka* is unavailable.

### Limitations and Clinical Need

While laboratory analysis and literature review show strong grounds for substitution, clinical trials are essential to:

- Establish therapeutic equivalence in specific disorders (e.g., *Amavata*, *Kustha*, *Arsha*).
- Determine optimal dosage equivalence.
- Evaluate long-term safety when used as a replacement.

### Conclusion

*Chitrak* shares substantial similarities with *Bhallataka* in phytochemistry, physicochemistry, and Ayurvedic properties. It can be recommended as an *Abhaya-pratinidhi dravya* in cases where *Bhallataka* is unavailable or contraindicated, though clinical validation is warranted.

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