Pharmacognostical, Physicochemical, and HPLC Standardization of Duralabhadi Kwath: A Traditional Herbal Formulation for Respiratory Disorders

Purnima Baghel*[1], Dheeraj Ahirwar[1], Bharti Ahirwar[2]

[1]School of Pharmacy, Chouksey Engineering College, Bilaspur – 495004, Chhattisgarh, India
[2]Institute of Pharmaceutical Sciences, Guru Ghasidas Vishwavidyalaya, (A Central University) Bilaspur – 495001, Chhattisgarh, India

***Corresponding author**
Purnima Baghel
School of Pharmacy, Chouksey Engineering College, Bilaspur – 495004, Chhattisgarh, India

Abstract:

Respiratory disorders such as asthma, COPD, bronchitis, and allergic rhinitis contribute significantly to global morbidity, with an even higher burden in developing regions due to air pollution and biomass exposure. Traditional herbal formulations remain widely practiced in rural and tribal areas of Chhattisgarh; however, scientific validation of their identity, purity, and phytochemical profile is limited. The present study focuses on the pharmacognostical, physicochemical, and chromatographic standardization of *Duralabhadi Kwath*, a classical polyherbal decoction consisting of *Fagonia indica, Fumaria indica, Picrorhiza kurroa, Trichosanthes dioica, Piper nigrum,* and *Commiphora wightii*. The formulation was prepared following the Ayurvedic Formulary of India guidelines using a 1:16 decoction ratio, yielding 80 mL of extract from 60 g of raw material. Physicochemical parameters-including pH (5.8 ± 0.1), extractive values (water: 25.4 ± 0.7%; alcohol: 17.9 ± 0.5%), ash values, swelling index, foaming index, and microbial load were within pharmacopoeial limits, indicating purity, safety, and good phytochemical richness. HPLC fingerprinting at 320 nm revealed nine major peaks corresponding to phenolic acids, flavonoids, tannins, terpenoids, and essential oil derivatives, with compounds such as gallic acid, ellagic acid, and quercetin showing known antioxidant, bronchodilatory, and anti-inflammatory activities relevant to respiratory health. The results confirm that Duralabhadi Kwath possesses a diverse spectrum of bioactive constituents with potential anti-asthmatic, immunomodulatory, and mucosal protective effects. The standardized profile established in this study provides a scientific basis for its traditional use and supports its future application in evidence-based respiratory therapeutics.

Keywords: Duralabhadi kwath; Herbal formulation; Respiratory disorders; Asthma management; Pharmacognostical evaluation; Physicochemical standardization; HPLC fingerprinting; Phytochemical profiling

1. Introduction

Respiratory disorders represent a major public health challenge worldwide and are among the leading causes of morbidity and mortality. These include asthma, chronic obstructive pulmonary disease (COPD), allergic rhinitis, bronchitis, and respiratory tract infections, all of which contribute significantly to impaired lung function and decreased quality of life. [1] According to the World Health Organization, respiratory diseases account for more than 10% of global Disability-Adjusted Life Years (DALYs), with asthma and COPD ranking among the most prevalent chronic conditions (WHO, 2023). Asthma is characterized by chronic airway inflammation, bronchial hyper-responsiveness, and reversible airflow obstruction, leading to symptoms such as wheezing, coughing, and episodic breathlessness [2] In contrast, COPD is a progressive disorder marked by persistent airflow limitation due to chronic bronchitis and emphysema, commonly triggered by tobacco smoke and environmental pollutants Allergic respiratory conditions, including allergic rhinitis and atopic asthma, arise from IgE-mediated hypersensitivity reactions that activate mast cells and inflammatory pathways India carries a substantial burden of respiratory disorders due to rapid urbanization, biomass fuel exposure, air pollution, and occupational dust. [3] In regions like Chhattisgarh, frequent use of biomass for cooking, forest- derived pollen exposure, and seasonal climatic variations contribute to increased incidence of asthma and allergic respiratory diseases Although modern medications—such as bronchodilators, corticosteroids, antihistamines, and leukotriene modifiers—are effective, long-term use is often associated with adverse effects and poor adherence. Traditional herbal remedies continue to be widely used in rural and tribal communities of Chhattisgarh for respiratory ailments. [4] These formulations, prepared using locally available medicinal plants, are known for their anti-inflammatory, bronchodilator, antitussive, and immunomodulatory properties. However, scientific validation and standardization of such herbal formulations remain limited. Lack of pharmacognostical and phytochemical characterization hampers their integration into evidence- based therapeutic practice. Therefore, systematic pharmacognostical and phytochemical standardization is essential to ensure the identity, purity, safety, and therapeutic consistency of these traditional formulations. Scientific validation of these herbal preparations will strengthen their credibility, promote their rational use, and support their inclusion in modern respiratory healthcare systems. [5]

2. Materials and Methods

Collection of plant samples and purchasing of raw ingredients

The raw materials required for the preparation of Duralabhadi Kwath were obtained through a combination of local collection and market procurement. Plant-based ingredients such as Dhamasa (Fagonia cretica), Pittapapda (Fumaria indica), Kutki (Picrorhiza kurroa), leaf of pointed gourd (Trichosanthes dioica), black pepper (Piper nigrum), and guggul (Commiphora wightii) were collected from the herbal gardens and forested regions of Pendra and surrounding areas in Chhattisgarh, based on their documented ethnobotanical availability and use in local traditional medicine.

Authentication of plant samples

The collected plant materials were botanically authenticated at the Botany Department, Guru Ghasidas Vishwavidyalaya, Bilaspur Chhattisgarh with Reference no. Bot./GGV/2025/181. Taxonomic identification was performed based on morphological and microscopic characteristics using standard floras and reference herbarium samples. Voucher specimens were deposited for each plant sample for future verification and academic reference.

Table 1: Herbal formulation profiling.

Name of Herbal Formulation	Common and Botanical Name (Family)	Responsible for Activities	Phytochemical Constituents
1.Duralabhadi Kwath	Dhamasa (*Fagonia indica*) - Zygophyllaceae	Exhibits significant antioxidant and anti-inflammatory activities; used traditionally in liver and metabolic disorders [6]	Flavonoids, alkaloids, saponins, tannins
	Pittpapda (*Fumaria indica*) – Papaveraceae	Reported for its hepatoprotective, purgative, and detoxifying properties in liver disorders and skin diseases [7]	Alkaloids (fumarin), flavonoids, tannins
	Kutki (*Picrorhiza kurroa*) – Plantaginaceae	Demonstrates anti-asthmatic, hepatoprotective, and immunomodulatory effects [8]	Iridoid glycosides (picroside I & II), kutkin
	Pointed gourd (*Trichosanthes dioica*) – Cucurbitaceae	Known for hypoglycemic, hepatoprotective, and antioxidant effects [9]	Flavonoids, saponins, phenolic acids
	Black Pepper (*Piper nigrum*) – Piperaceae	Used as bronchodilator, antimicrobial, and enhances absorption of co-administered drugs [10]	Piperine, essential oils, flavonoids
	Guggul (*Commiphora wightii*) – Burseraceae	Possesses potent anti-inflammatory, antioxidant and hypolipidemic effects	Guggulsterones, terpenoids, steroids [11]

Preparation of Duralabhadi kwath

Duralabhadi Kwath was prepared using the classical *Kwath Kalpana* (decoction preparation) technique, standardized for aqueous extraction efficiency. The formulation comprised Dhamasa (*Fagonia indica*), Pittpapda (*Fumaria indica*), Kutki (*Picrorhiza kurroa*), Pointed Gourd leaves (*Trichosanthes dioica*), Black Pepper (*Piper nigrum*), and Guggul (*Commiphora wightii*), each weighed accurately at 10 grams to obtain a total of 60 grams of crude drug powder. [12] [13]

All ingredients were coarsely powdered and transferred into a beaker containing 960 mL of distilled water, maintaining the traditional ratio of 1:16 (drug: solvent), as outlined in Ayurvedic Formulary of India. [14] The decoction was gently boiled on a calibrated hot plate at 90 ± 2 °C with constant stirring to ensure even extraction. The heating process was continued until the volume was reduced to one-eighth (~80 mL), ensuring concentration of phytoconstituents without thermal degradation. The decoction was allowed to reach room temperature, subsequently filtered through a muslin cloth, and transferred into pre-sterilized, sealed containers to prevent contamination. [15] Thereafter, the obtained extract underwent evaluation for parameters such as pH, viscosity, and microbial burden, following the quality control standards recommended by WHO and ICH Q6A guidelines (ICH, 2000) to ensure both safety and standardization. [16]

Fig.1. Preparation of Duralabhadi kwath.

Table 2: Formulation and physicochemical properties of Duralabhadi kwath.

Formulation	Total Raw Material Used (g)	Final Yield Obtained (mL/g)	Physical Appearance	Organoleptic Characteristics (Colour, Odour, Taste, Texture)
Duralabhadi Kwath	60 g	80 mL	Brownish liquid	Dark brown colour, bitter taste, characteristic odour, thin viscosity

3. Result

Physicochemical evaluation of herbal formulations

The physicochemical parameters of Duralabhadi kwath, were systematically evaluated to establish quality standards, ensure reproducibility, and confirm suitability for pharmacological investigations related to respiratory disorders.

Table 3: Physicochemical evaluation of prepared herbal formulations.

Parameter	Duralabhadi Kwath
Extractive Values (% w/w)	Water: 25.4 ± 0.7 Alcohol: 17.9 ± 0.5
Ash Values (% w/w)	Total: 5.84 ± 0.13 Acid-insoluble: 1.67 ± 0.09 Water-soluble: 3.12 ± 0.10
Bitterness Value (×10³)	1.25
Foaming Index	<100
Hemolytic Activity (%)	None
Swelling Index (mL/g)	1.5
Microbial Load (cfu/g)	>10
Heavy Metals (ppm)	Pb: 0.17, Hg: 0.18
Loss on Drying (% w/w)	5.16 ± 0.19
pH (1% w/v solution)	5.8 ± 0.1

All values are mean ± SD of triplicate determinations. Microbial load and heavy metals were within permissible pharmacopoeia limits.

The physicochemical analysis highlighting the unique characteristics and therapeutic potential of Duralabhadi Kwath emerged as the formulation with the highest phytochemical richness. Its aqueous extractive value (25.4%) and alcohol extractive value (17.9%) were superior, suggesting a broad spectrum of both polar and semi- polar bioactive constituents. These findings support its reported bronchodilatory, anti-inflammatory, and immunomodulatory properties.

The ash values (total: 5.84%, acid-insoluble: 1.67%) were within pharmacopoeial limits, indicating purity and absence of extraneous inorganic adulterants. A moderate swelling index (1.5 mL/g) indicates mucilage presence that could provide soothing effects on respiratory mucosa. Slightly acidic pH (5.8) may facilitate solubility and stability of phytoconstituents. Importantly, microbial and heavy metal levels were within safe limits, confirming its safety for further pharmacological evaluation.

Duralabhadi kwath – Highest extractive values, optimal ash profile, and favorable physicochemical parameters, making it the most phytochemically rich and therapeutically promising formulation.

HPLC fingerprinting of herbal formulations (Duralabhadi Kwath; Sample Code: R1)

The HPLC chromatogram of Duralabhadi Kwath (Sample Code: R1) at 320 nm revealed a unique phytochemical fingerprint, with nine distinct peaks appearing between retention times of 0.714 and 9.414 minutes (Fig.2). On the horizontal axis, the retention duration is expressed in minutes, whereas the vertical axis depicts the detector response in millivolts, reflecting the relative concentration of eluted compounds. The chromatographic separation was performed using methanol:ethyl acetate (30:70) as the mobile phase, and a detection wavelength of 320 nm was chosen due to its suitability for identifying phenolic constituents, flavonoids, and other polyphenolic derivatives.

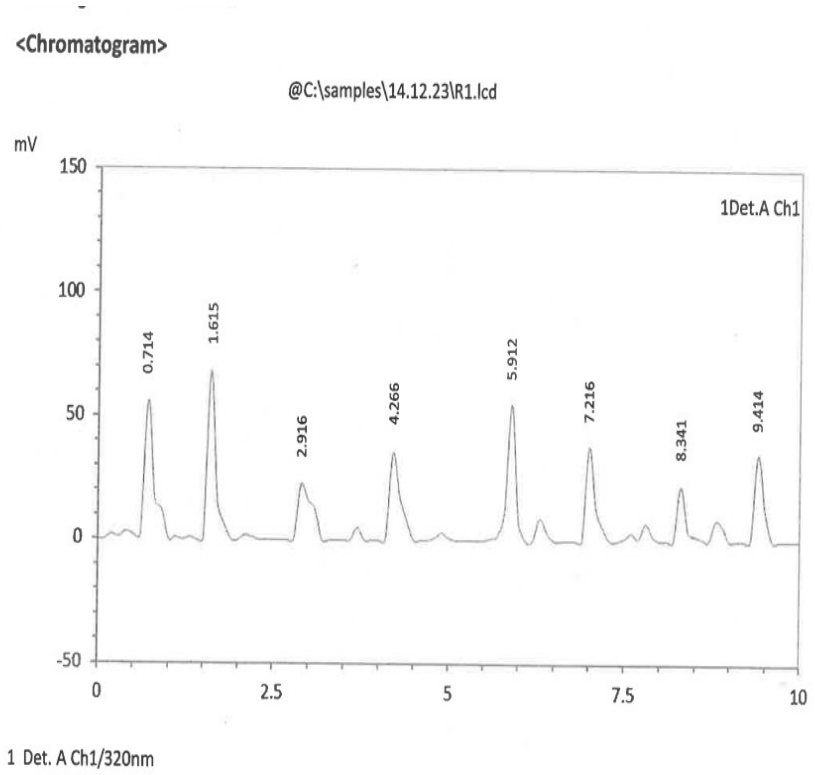

Fig.2. HPLC chromatogram of Duralabhadi kwath at 320 nm (Solvent system: Methanol:Ethyl Acetate, 30:70).

Table 4: Retention time and Area Under Curve (AUC) of major peaks in Duralabhadi kwath (R1).

Peak No.	Retention Time (min)	Area Under Curve (AUC)	Probable Phytochemical	Remarks on Anti-asthmatic Potential
1.	0.714	14598	Phenolic acid (polar)	Antioxidant, reduces oxidative stress
2.	1.615	17458	Gallic acid / Polyphenol	Potent antioxidant, anti-inflammatory
3.	2.916	5516	Tannin derivative	Astringent, airway protective
4.	4.266	8745	Ellagic acid / Chebulinic acid	Anti-allergic, mast cell stabilizer
5.	5.912	13745	Quercetin / Flavonoid	Bronchodilator, mast cell stabilizer
6.	7.216	9546	Flavonoid derivative	Enhances anti-inflammatory activity
7.	8.341	5500	Polyphenol / Glycoside	Contributes synergistic effect
8.	9.414	8750	Terpenoid / Essential oil	Smooth muscle relaxant, mucosal soothing

4. Discussion

It can be seen from Fig. 2 that the early eluting peaks (0.7–3.0 min) represent polar compounds such as gallic acid, ellagic acid, and related phenolic derivatives. These compounds have been widely reported for their strong antioxidant and anti-inflammatory activity, which is crucial in bronchial asthma management by mitigating airway inflammation and oxidative injury. Peaks detected at intermediate retention times (4.2–7.2 min) suggest medium-polarity phytoconstituents, including chebulinic acid and flavonoid derivatives such as quercetin. These metabolites have been reported to exhibit bronchodilatory, mast cell–stabilizing, and immunomodulatory activities, thereby reinforcing their prospective role in the management of asthma. Late eluting peaks (8.3–9.4 min) correspond to non-polar phytoconstituents such as terpenoids and essential oil derivatives. These molecules may provide smooth muscle relaxation and mucosal protective effects in the respiratory tract, contributing to symptomatic relief in asthma. The overall HPLC profile of Duralabhadi kwath demonstrates a balanced representation of phenolics, flavonoids, tannins, terpenoids, and essential oil components. This diverse phytochemical distribution is highly significant in the context of the present study objectives, as the synergistic interplay of these compounds underpins the antioxidant, anti-inflammatory, and immunomodulatory potential of the formulation. Therefore, the chromatographic fingerprint not only supports its traditional therapeutic claim in respiratory disorders but also provides a robust tool for standardization and quality assurance of Duralabhadi kwath.

5. Conclusion

Duralabhadi Kwath, a traditional herbal formulation used in the management of respiratory disorders, was systematically standardized through pharmacognostical, physicochemical, and chromatographic evaluations. The extractive values, ash parameters, pH, and microbial safety profile confirmed the formulation's purity and suitability for therapeutic use. HPLC fingerprinting revealed a wide range of bioactive components including phenolic acids, flavonoids, tannins, and terpenoids responsible for antioxidant, bronchodilatory, and anti-inflammatory activities, validating its traditional claims in asthma and other respiratory conditions. The study establishes a reproducible fingerprint and quality standards for Duralabhadi Kwath, ensuring identity, consistency, and authenticity. These findings strengthen the scientific basis for its use in respiratory healthcare and pave the way for further pharmacological, toxicity, and clinical studies to explore its full therapeutic potential.

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