

Recent Advancements in Analytical Techniques of AYUSH Drugs: A Cross-Disciplinary Correlation between Classical Ayurvedic Evaluation and Modern Analytical Validation

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ABSTRACT

Ayurveda offers a deep analytical approach to understanding medicines. The concept of *Dravya Pariksha* and *Pramana Vijnana* forms its foundation. Classical texts such as *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya* describe how each drug should be tested through *rasa*, *guna*, *veerya*, *vipaka*, and *prabhava*. These qualities ensure identity, purity, potency, and safety.

Modern analytical science follows the same principle but with advanced tools. Methods like HPTLC, HPLC, GC-MS, FTIR, and SEM provide measurable data to validate traditional observations. Nano-analysis of *bhasma* and *asava-arishta* preparations confirms the scientific logic behind ancient methods.

This review connects classical Ayurvedic testing with modern analytical validation. It shows that Ayurveda had an experimental and logical base long before laboratory science evolved. Combining *Samhita*-based principles with modern instruments creates a balanced system of qualitative and quantitative analysis. Such integration ensures reliable, standardised, and globally accepted Ayurvedic medicines.

Keywords: Ayurveda, *Dravya Pariksha*, *Pramana Vijnana*, Analytical Validation, *Bhasma Pariksha*, Standardisation.

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INTRODUCTION

Ayurveda, the ancient Indian medical science, offers a complete and systematic approach to health care. Its foundation rests on *dravya vigyana* (study of medicinal substances) and *bhaishajya kalpana* (formulation science). The classical texts - *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya* - describe detailed methods of *dravya pariksha* (drug examination). Parameters like *rasa* (taste), *guna* (qualities), *veerya* (potency), *vipaka* (post-digestive effect) and *prabhava* (specific action) were used to assess identity, purity and

efficacy of drugs [1]. These ancient analytical methods show deep empirical understanding, even without modern instruments.

In the present era, the global demand for traditional medicines is increasing. This has created a strong need for quality assurance and standardisation of AYUSH drugs. Modern analytical techniques such as High-Performance Thin Layer Chromatography (HPTLC), High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), Fourier Transform Infrared Spectroscopy (FTIR) and

UV-Visible Spectrophotometry help ensure quality, purity and reproducibility of herbal preparations [2]. These tools provide measurable parameters that validate traditional observations.

Recent advancements have made analytical science more sensitive and accurate. New platforms like Ultra-Performance Liquid Chromatography (UPLC), Liquid Chromatography-Mass Spectrometry (LC-MS/MS), and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) are widely used to profile phytochemicals and identify bioactive compounds. In the case of bhasma, nanometric analysis by Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD) has confirmed the scientific basis of ancient preparation methods [3].

This review aims to bridge the classical and modern approaches to drug evaluation. It attempts to correlate dravya pariksha paddhati from Ayurvedic texts with present-day analytical validation techniques. The goal is to show that both systems, though different in tools and terminology, follow the same scientific spirit - observation, analysis and verification. Such an integrated approach can strengthen the credibility of Ayurveda and promote its acceptance under global pharmacopoeial standards.

MATERIALS AND METHODS

This review adopts a cross-disciplinary approach integrating Ayurvedic textual analysis with modern analytical and biostatistical literature. Data were compiled from classical Samhitas, published AYUSH research papers, and institutional academic material.

Classical Sources

Primary information was taken from Charaka Samhita, Sushruta Samhita and Ashtanga Hridaya. The methods of dravya pariksha mentioned by Charaka Sutra 1/25 and Sushruta Sutra 36/10 formed the basis for traditional drug evaluation. Concepts of rasa, guna, veerya, vipaka and prabhava were examined to interpret qualitative assessment systems described for identification, purity, and potency [1]. Ashtanga Hridaya Sutra 5/15 was referred to for the role of pratyaksha, anumana and yukti pramana in logical verification of drug properties. Commentaries explaining bhasma pariksha and aushadha yog pariksha paddhati were also reviewed.

Modern Analytical Sources

Modern analytical data were drawn from the ITRA Jamnagar Certificate Programme on Research Methodology and Biostatistics, covering chromatography, pharmacology, toxicology, and statistical validation. Research articles from AYU Journal [2], JDRAS [3], and recent AYUSH publications [4] provided information on HPTLC, HPLC, GC-MS, FTIR, and spectrophotometric methods used for drug standardisation.

ANALYTICAL FRAMEWORK

Data were categorised into three domains:

Classical Parameters	Analytical	textual qualitative attributes from Samhitas;
Modern Techniques	Analytical	Instrumental quantitative parameters;
Integrative Correlation		mapping between both.

Comparative and descriptive analysis was applied to derive parallels between Samhita-based drug evaluation and modern validation tools. Biostatistical procedures described in ITRA supported reliability testing and interpretation [5].

OBSERVATIONS / RESULTS

The comparative analysis between classical Ayurvedic and modern analytical methods revealed several areas of conceptual similarity and practical complementarity.

Classical Observations

Ayurvedic texts emphasise multi-level examination of drugs. Charaka Samhita describes that proper understanding of dravya is essential for successful therapy

“द्रव्यं च द्रव्यज्ञानं च चिकित्सायां प्रधानम् ।”

(Charaka Samhita, Sutra Sthana 1/25)

The parameters of rasa, guna, veerya, vipaka, and prabhava serve as qualitative analytical tools for identifying and classifying substances.

Sushruta Samhita mentions that even the smallest change in rasa or veerya can alter therapeutic efficacy (Sushruta Sutra 36/10) [2]. Ashtanga Hridaya further defines dravya pariksha paddhati based on pratyaksha (direct observation), anumana (inference), and yukti (logical correlation) [3]. These methods parallel the principles of systematic analysis, reproducibility, and evidence that modern science follows.

Modern Analytical Observations

Modern tools such as HPTLC, HPLC, and GC-MS provide quantifiable data for purity, marker compounds, and stability. The use of FTIR and UV-Visible spectroscopy helps identify functional groups and absorption characteristics of phytoconstituents.

In metallic preparations like bhasma, analytical techniques such as X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM) have confirmed the nano-structural nature of the particles (25-50 nm range) [4]. This validates traditional bhasma pariksha tests like varitara (floatability) and nishchandravta (lustre loss).

Integrative Results

The integrative study shows that Ayurvedic qualitative parameters can be mapped to measurable analytical indicators. For example, rasa corresponds to chemical composition, guna to physical properties like texture and solubility, veerya to pharmacodynamic potency, and vipaka to metabolic transformation. The traditional empirical evaluation of bhasma or aushadha yogas can thus be scientifically validated through instrumental and biostatistical approaches [5].

DISCUSSION

Ayurveda defines the science of medicine not only as a therapeutic discipline but also as a rigorous analytical system. The concept of dravya pariksha (drug examination) establishes a logical framework for evaluating medicinal substances through observation, reasoning, and experience.

Charaka Samhita declares that

“द्रव्यं च द्रव्यज्ञानं च चिकित्सायां प्रधानम्।”

the knowledge of substances is central to successful treatment (Charaka Sutra 1/25) [1]. This statement itself reflects the analytical orientation of classical Ayurveda. Unlike descriptive ethnobotany, dravya pariksha in Ayurveda is a structured process combining empirical examination with philosophical reasoning.

Analytical Philosophy in Ayurveda

The foundation of Ayurvedic analysis lies in pramana vijnana - the science of valid knowledge. The triad of pratyaksha (direct perception), anumana (inference), and yukti (rational application) mentioned in Ashtanga Hridaya Sutra 5/15 represents the three stages of modern analytical methodology:

“प्रत्यक्षानुमानयुक्तित्रिविधं प्रमाणम्।”

(Ashtanga Hridaya, Sutra Sthana 5/15)

observation, interpretation, and experimental verification [2]. The Anumana Pariksha process described by Sushruta parallels the inferential logic behind hypothesis-driven modern research. Hence, classical Ayurvedic analysis can be considered the earliest epistemological form of experimental validation.

Pramana Pariksha as the Analytical Foundation of Ayurveda

The analytical strength of Ayurveda originates from its doctrine of Pramana Vijnana-the science of valid knowledge. Ashtanga Hridaya Sutra 5/15 defines three core pramanas: pratyaksha (direct observation), anumana (inference), and yukti (rational experimentation). Pratyaksha represents sensory evaluation similar to empirical observation in laboratory testing. Anumana correlates with logical interpretation and predictive reasoning used in analytical chemistry. Yukti denotes the experimental and innovative application of multiple observations, analogous to modern method validation. Together, these pramanas create a systematic approach to verify truth through observation, logic, and experimentation-forming the earliest version of scientific analysis in medical science [2]. Thus, pramana pariksha serves as the philosophical and methodological foundation of Ayurvedic drug evaluation.

In dravya pariksha, each parameter - rasa, guna, veerya, vipaka, and prabhava - acts as an analytical marker. The rasa (taste) is evaluated through indriya pariksha (sensory analysis) which determines the nature of active constituents. For instance, tikta rasa indicates the presence of alkaloids or glycosides, known for anti-

inflammatory or detoxifying action [3]. Guna (quality) refers to physical and functional attributes like laghu (lightness) or guru (heaviness), comparable to physical parameters such as density, viscosity, and solubility. Veerya (potency) reflects pharmacodynamic activity, while vipaka (post-digestive effect) resembles pharmacokinetic transformation. Prabhava denotes specific, unexplained pharmacological effects, similar to receptor-level selectivity in modern pharmacology.

Textual Analytical Parameters and Scientific Correlation

“रसगुणवीर्यविपाकप्रभावैः पृथक् पृथक्”।

(Sushruta Samhita, Sutra Sthana 36/10)

In modern terms, the Ayurvedic analytical process covers all essential steps of contemporary drug validation - identity, purity, potency, and safety. For example, rasa pariksha corresponds to organoleptic and chromatographic analysis; guna pariksha correlates with physical property testing (pH, moisture content, refractive index); veerya pariksha equates to bioassay and stability testing; while prabhava is comparable to pharmacological specificity tested through in-vitro and in-vivo assays [4].

Ayurvedic bhasma pariksha paddhati (metallic drug testing) described in Rasatarangini and Ayurveda Prakasha includes parameters such as rekhapurnata (fineness), nishchandratva (lustre loss), varitara (float test), and nirmalatva (purity). These correspond to modern metallurgical tests like Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and X-ray Diffraction (XRD). Recent studies using SEM and XRD confirmed that bhasmas are composed of nanoparticles ranging between 25-50 nm, showing crystalline homogeneity and absence of free metal ions [5]. Such observations establish the scientific validity of classical analytical procedures.

MODERN ANALYTICAL TECHNIQUES AND VALIDATION

Modern instrumentation provides reproducible data that strengthen traditional claims. Chromatographic techniques such as High-Performance Thin Layer Chromatography (HPTLC) and High-Performance Liquid Chromatography (HPLC) generate chemical fingerprints that help in identifying the unique phytoconstituents of Ayurvedic formulations. Gas Chromatography-Mass Spectrometry (GC-MS) detects volatile and thermolabile compounds, while Fourier Transform Infrared Spectroscopy (FTIR) identifies functional groups in complex plant matrices [6].

Advanced methods like Ultra-Performance Liquid Chromatography (UPLC), Liquid Chromatography-Mass Spectrometry (LC-MS/MS), and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) enhance sensitivity and accuracy. These tools are particularly useful in analysing Rasaushadhi and Herbo-Mineral preparations.

Spectroscopic methods such as Nuclear Magnetic Resonance (NMR) and UV-Visible Spectrophotometry further contribute to structural elucidation and quantitative estimation. In asava-arishta formulations, chromatographic fingerprinting helps verify fermentation markers, ensuring batch-to-batch consistency. These analytical advancements represent the “quantitative face” of the qualitative insights found in Samhita descriptions.

Data Interpretation and Biostatistical Validation

The integration of biostatistics has brought analytical standardisation closer to scientific precision. As discussed in the ITRA Research Methodology sessions (40-49), descriptive statistics, standard deviation, and correlation analysis are essential for assessing reproducibility and accuracy in analytical data. Variations in sample readings can be quantified through measures of variability and hypothesis testing [7].

Correlation models such as Pearson's and Spearman's tests can be applied to study relationships between guna-rasa-veerya and chemical markers like alkaloid content, total phenolic concentration, or antioxidant potential. These statistical relationships bridge subjective Ayurvedic evaluation with objective laboratory parameters.

Integration and Global Relevance

A major advancement in AYUSH analytical research is the recognition of phytopharmaceuticals - multi-constituent plant preparations regulated through validated analytical profiles [8]. The modern definition of quality control now includes fingerprint profiling, biomarker quantification, and chemotaxonomic identification. This reflects the classical Ayurvedic approach, which always considered the whole extract (sarvanga dravya) more potent than isolated components.

Moreover, reverse pharmacology and network pharmacology approaches have revived the experimental foundation of Ayurveda. These methodologies start from clinical efficacy and move backward to laboratory validation, paralleling yukti pramana - logical reasoning from outcome to cause [9]. Artificial intelligence is now being applied to analyse large analytical datasets, predict bioactive interactions, and interpret HPTLC/HPLC chromatograms, making analytical validation faster and more reliable.

The integration of Samhita-based analytical parameters with advanced instrumental methods ensures that traditional wisdom is scientifically validated without distortion. Such work aligns with WHO-GMP standards, the AYUSH pharmacopoeial guidelines, and the principles of evidence-based medicine.

Analytical Continuity

The findings of this cross-disciplinary study demonstrate that Ayurveda anticipated analytical thinking centuries ago. The qualitative categories described in Charaka

Samhita and Sushruta Samhita were precursors to today's physicochemical and pharmacological classifications. Modern technology merely quantifies what Ayurveda already described in experiential terms. Recognising this analytical continuity will help transform AYUSH research from descriptive traditionalism to global scientific acceptance.

CONCLUSION

1. Ayurveda established a strong analytical foundation through dravya pariksha and pramana vijnana, focusing on observation, inference, and rational validation.
2. Classical parameters like rasa, guna, veerya, vipaka, and prabhava represent qualitative analytical markers equivalent to modern physicochemical and pharmacological parameters.
3. Modern analytical tools such as HPTLC, HPLC, GC-MS, FTIR, and spectroscopy have made it possible to quantify and validate traditional drug assessments.
4. Bhasma analysis through SEM, XRD, and TEM confirms nano-sized particles, validating ancient bhasma pariksha tests.
5. Statistical tools from biostatistics ensure precision, reproducibility, and reliability in AYUSH drug standardisation.
6. Integrating Samhita-based principles with modern instrumentation creates a unified analytical model that combines qualitative wisdom with quantitative accuracy.
7. This approach will strengthen scientific credibility, promote global acceptance of AYUSH drugs, and support the development of standardised, evidence-based Ayurvedic pharmaceuticals.

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