

## Cell line studies in Ayurveda: Bridging ancient wisdom and modern science

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### Abstract

Ayurveda, an ancient Indian system of medicine, offers holistic solutions to modern health challenges by addressing the root causes of illness. In recent years, there has been a growing interest in integrating Ayurveda with modern scientific approaches through interdisciplinary research to explore synergies and uncover novel insights for healthcare advancements. Cell line studies are emerging as a pivotal tool in this effort. These studies facilitate the exploration of the molecular mechanisms underlying Ayurvedic principles and formulations, offering valuable insights into their therapeutic efficacy. This review article evaluates the role of cell line studies in bridging the gap between ancient Ayurvedic wisdom and modern scientific understanding. It provides an overview of existing research on cell line studies of Ayurvedic medicines, exploring their effectiveness, identifying key herbs and formulations studied, discussing clinical and pharmacological findings, addressing challenges and future directions, and emphasizing the importance of scientific validation when integrating Ayurveda into conventional healthcare.

**Keywords:** Ayurveda; Cell line studies; Traditional medicine; Modern science

### 1. Introduction

Ayurveda, an ancient Indian medical tradition, has endured over time, offering holistic methods for promoting health and well-being. In today's era marked by chronic diseases and stress-related ailments, Ayurveda offers comprehensive solutions that address the underlying causes of illness rather than merely alleviating symptoms. Its individualized approach, which takes into account individual constitution, dietary habits, lifestyle, and mental well-being, aligns with contemporary trends towards personalized medicine and patient-centered care. In recent years, there has been a growing interest in integrating traditional systems of medicine such as Ayurveda with modern scientific approaches. Cell line studies have become instrumental in deciphering the molecular mechanisms underlying Ayurvedic principles and formulations. Cell line studies provide a controlled environment for evaluating the biological effects of Ayurvedic compounds on cellular mechanisms relevant to health and disease.

This article seeks to evaluate the role of cell line studies in bridging the gap between ancient Ayurvedic wisdom and modern scientific knowledge. Existing research on cell line studies of Ayurvedic medicines were reviewed, highlighting challenges and future directions, and underscoring the significance of scientific validation when integrating Ayurveda into mainstream healthcare.

### 2. Cell Line Studies in Modern Research

Cell line studies are a cornerstone of modern pharmacology, offering significant understanding into the mechanisms of action, effectiveness, and safety profiles of pharmaceutical compounds. These studies involve the cultivation of immortalized cells sourced from various tissues or organs under controlled laboratory conditions. By simulating

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physiological conditions *in vitro*, cell line studies facilitate researchers to investigate the effects of drugs and other substances on cellular processes, such as proliferation, differentiation, metabolism, and signalling pathways. [1,2]

In modern pharmacology, cell line studies serve manifold purposes, including drug discovery, mechanistic investigations, toxicity screening, and preclinical evaluation. [3] They offer a cost-effective and ethically acceptable substitute for animal trials while providing pertinent and reproducible data that can inform subsequent phases of drug development. Furthermore, cell line studies allow for swift screening of large compound collections, facilitating the identification of promising lead compounds for further optimization.

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### 3. Techniques used in cell line studies and their relevance in testing Ayurvedic formulations

Various methods are employed in cell line studies to evaluate the pharmacological properties of Ayurvedic formulations and unveil their mechanisms of action. [4] These techniques encompass assessments such as cell viability assays, proliferation assays, apoptosis assays, cell cycle analysis, gene expression analysis, and protein profiling. Each technique yields specific insights about the effects of Ayurvedic compounds on cellular function and molecular pathways. [5]

Cell viability assays, such as the MTT assay or Alamar Blue assay, gauge the metabolic activity of cells treated with Ayurvedic compounds, shedding light on their cytotoxicity and cell viability.[6] Proliferation assays, such as BrdU incorporation assay or EdU assay, assess the effect of Ayurvedic formulations on cell division and replication, crucial for understanding their impact on cellular growth.[7] Apoptosis assays, including Annexin V staining or TUNEL assay, bring to light the ability of Ayurvedic compounds to induce programmed cell death, offering insights into their potential as anti-cancer agents or regulators of cell survival. Gene expression analysis techniques, such as RT-qPCR or microarray analysis, aid in identifying changes in gene expression patterns triggered by Ayurvedic treatments, elucidating their molecular targets and signalling pathways. Protein profiling techniques, like Western blotting or immunofluorescence staining, allow for the detection and quantification of specific proteins involved in cellular responses to Ayurvedic compounds thereby aids in comprehending their mechanisms of action. Collectively, these cell line study techniques provide valuable tools for evaluating the pharmacological properties of Ayurvedic medicines, paving the way for their development and integration into evidence-based medical practice. [8]

Thus, cell line studies are invaluable for evaluating the pharmacological characteristics of Ayurvedic remedies and elucidating their molecular mechanisms in cellular models, thereby validating and transitioning them into clinical use.

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### 4. Previous works on cell line studies in Ayurveda

Cell line studies have been instrumental in Ayurvedic research, providing insights into the efficacy of herbs, formulations, and treatments across diverse health conditions. Particularly noteworthy are the studies which demonstrated the cytotoxic effects of Ayurvedic herbal extracts on cancer cell lines derived from breast, lung, prostate, and colon cancers, suggesting the possibility of using the herbs as adjuvant therapies in cancer management.[9] Furthermore, Ayurvedic formulations containing bioactive compounds like flavonoids and polyphenols, exhibit anti-inflammatory effects, with cell line studies revealing their mechanisms by targeting key inflammatory mediators and signalling pathways.[10] Moreover, Ayurvedic herbs with antioxidant properties have demonstrated potential in mitigating oxidative damage implicated in cardiovascular disorders, neurodegenerative diseases, and cancer, as validated by cell line studies.[11] Moreover, assessment of herbal extracts on liver cell viability, enzyme activity, and lipid metabolism in cell line models supports their therapeutic potential for hepatitis, cirrhosis, and fatty liver disease. Similarly, Ayurvedic formulations with herbs like Brahmi and Ashwagandha have exhibited neuroprotective properties in cell line models of Alzheimer's and Parkinson's disease, highlighting their ability to bolster neuronal resilience, reduce oxidative stress, and modulate neuroinflammatory pathways. [12,13,14] These findings underscore the pharmacological significance of Ayurvedic medicine in modern healthcare, paving the way for further research, clinical trials, and integration into conventional healthcare practices.

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### 5. Methodological Hurdles in Ayurvedic Cell Line Studies

Analysing Ayurvedic formulations using cell lines presents several methodological challenges that researchers must overcome to ensure the validity and reliability of their findings. Firstly, standardizing herbal extracts is imperative due to the complex mixtures of herbs, minerals, and compounds involved in Ayurvedic formulations. Variations in plant species, cultivation conditions, and extraction techniques pose challenges in ensuring consistent biological activity across experiments, necessitating stringent standardization procedures. Secondly, selecting appropriate cell lines is crucial but challenging. Cell lines vary in sensitivity to herbal extracts and may react differently based on tissue origin,

genetic background, and physiological characteristics. Meticulous selection and validation of cell lines representing target tissues or diseases are necessary for precise assessment of Ayurvedic formulations. [15]

Furthermore, establishing dose-response relationships poses a challenge due to the absence of standardized dosing guidelines in Ayurveda. Variable dosages based on individual constitution make extrapolation to in vitro experiments challenging, highlighting the need for dose-response studies to understand concentration-dependent effects and avoid cytotoxicity. Additionally, interactions with cell culture media can influence the assessment of Ayurvedic remedies' biological activity. Optimization of culture conditions, including media composition and pH levels, is vital to minimize interference and ensure accurate evaluation. Lastly, interpreting results requires caution due to the complexity of herbal formulations and multifaceted cellular responses. Considering potential confounding factors such as synergistic interactions between herbal components and variability in experimental conditions is essential for deriving meaningful conclusions from cell line studies of Ayurvedic remedies.

### 5.1. Future Directions

Future avenues for research in the field of cell line studies in Ayurveda include the development of novel cell-based assays to screen Ayurvedic formulations for specific therapeutic targets, such as mitochondrial function, epigenetic modifications, and stem cell differentiation. Moreover, merging omics technologies, such as genomics, transcriptomics, and metabolomics, offers comprehensive insights into the molecular mechanisms driving the therapeutic effects of Ayurvedic compounds.

Furthermore, collaboration between traditional Ayurvedic practitioners and contemporary scientists is essential for translating laboratory findings into clinical applications. Clinical trials employing evidence-based Ayurvedic interventions can validate the efficacy and safety of herbal formulations identified through cell line studies, ultimately facilitating the way for their integration into mainstream healthcare systems.

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## 6. Conclusion

Cell line studies represent a valuable approach for exploring the pharmacological properties and mechanisms of action of Ayurvedic formulations. By employing cell-based models, researchers can uncover the therapeutic potential of Ayurvedic herbs and formulations in the management of various health conditions, including cancer, inflammation, oxidative stress, liver disorders, and neurodegenerative diseases. Moving forward, collaborative efforts between traditional Ayurvedic practitioners and modern scientists are essential for harnessing the full potential of Ayurveda in improving global health outcomes.

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## References

- [1] Go´mez-Lecho´n MJ, Donato MT, Castell JV, Jover R. Human hepatocytes as a tool for studying toxicity and drug metabolism. *Curr Drug Metab.* 2003;4:292–312. doi: 10.2174/1389200033489424. [PubMed] [CrossRef] [Google Scholar] [Ref list]
- [2] MacDonald C. Development of new cell lines for animal cell biotechnology. *Crit Rev Biotechnol.* 1990;10:155–78. doi: 10.3109/07388559009068265. [PubMed] [CrossRef] [Google Scholar]
- [3] Ghanemi A. Biological properties and perspective applications of “bio-neuter” chemicals? *Saudi Pharm. J.* 2014;22(1):1–2. [PMC free article] [PubMed] [Google Scholar] [Ref list]
- [4] Wang Y., Borlak J., Tong W. Chapter 6 – toxicogenomics – a drug development perspective. In: Yao Y., Jallal B., Ranade K., editors. *Genomic Biomarkers for Pharmaceutical Development.* Academic Press; San Diego: 2014. pp. 127–155. [Google Scholar]
- [5] Katiyar C, Gupta A, Kanjilal S, Katiyar S. Drug discovery from plant sources: An integrated approach. *Ayu.* 2012;33(1):10-19.
- [6] Ghasemi M, Turnbull T, Sebastian S, Kempson I. The MTT Assay: Utility, Limitations, Pitfalls, and Interpretation in Bulk and Single-Cell Analysis. *Int J Mol Sci.* 2021 Nov 26;22(23):12827. doi: 10.3390/ijms222312827. PMID: 34884632; PMCID: PMC8657538.
- [7] Bio-Rad. BrdU: Re-Discover the Lab Favorite for Cell Proliferation Analysis [Internet]. Bio-Rad. Available from: <https://www.bio-rad-antibodies.com/brdu-bromodeoxyuridine.html>

- [8] Ravishankar B, Shukla VJ, Patel CN, Ashok BK, De S. Research strategies to accelerate the Ayurvedic drug discovery process. *J Ethnopharmacol.* 2017;197:46-57.
- [9] Sharma RK, Prasad SK, Sengar N, et al. Chemopreventive role of *Coriandrum sativum* against gentamicin-induced renal histopathological damage in rats. *J Tradit Complement Med.* 2016;6(3):328-334.
- [10] Aggarwal BB, Prasad S, Reuter S, et al. Identification of novel anti-inflammatory agents from Ayurvedic medicine for prevention of chronic diseases: "reverse pharmacology" and "bedside to bench" approach. *Curr Drug Targets.* 2011;12(11):1595-1653.
- [11] Upadhyay AK, Kumar K, Kumar A, Mishra HS. *Tinospora cordifolia* (Willd.) Hook.f. and Thoms. (Guduchi) - validation of the Ayurvedic pharmacology through experimental and clinical studies. *Int J Ayurveda Res.* 2010;1(2):112-121.
- [12] Mishra LC, Singh BB, Dagenais S. Scientific basis for the therapeutic use of *Withania somnifera* (ashwagandha): a review. *Altern Med Rev.* 2000;5(4):334-346.
- [13] Trivedi MK, Patil S, Shettigar H, Bairwa K, Jana S. Characterization of physicochemical and structural properties of withaferin A: a comprehensive study. *J Pharm Sci Pharmacol.* 2016;3(2):93-98.
- [14] Singh N, Bhalla M, de Jager P, Gilca M. An overview on ashwagandha: a Rasayana (rejuvenator) of Ayurveda. *Afr J Tradit Complement Altern Med.* 2011;8(5 Suppl):208-213.
- [15] The Challenges, Applications and Research Scope of Cell Lines [Internet]. News- Medical. 2018 [cited 2024 Mar 8]. Available from: <https://www.news-medical.net/whitepaper/20181107/The-Challenges-Applications-and-Research-Scope-of-Cell-Lines.aspx>