

***Molecular Correlates of Twak Vikriti (Skin Disorders):
Transcriptome and Proteome Profiling Insights into Vicharchika
(Eczema) And Shwitra (Vitiligo) With Emphasis on Traditional
Ayurvedic Perspectives and Modern Systems Biology***

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ABSTRACT

Skin, as the most visible and dynamic organ of the human body, plays a pivotal role in both physiological and psychosocial health. In Ayurveda, skin disorders are classified under Twak Vikriti, with conditions such as Vicharchika (akin to eczema/dermatitis) and Shwitra (comparable to vitiligo) being emphasized due to their chronicity and impact on quality of life. Modern omics technologies, particularly transcriptome and proteome profiling, have enabled unprecedented insights into the molecular underpinnings of such diseases. This paper attempts to bridge the Ayurvedic conceptual framework of dosha imbalance with current findings from systems biology, outlining how immune dysregulation, oxidative stress, altered cytokine networks, and melanocyte dysfunction correspond to the classical descriptions of Twak Vikriti. Furthermore, the challenges, opportunities, and future directions for integrative research are presented, highlighting the potential for developing novel therapeutics and diagnostic strategies by combining traditional knowledge with molecular sciences.

KEYWORDS: *Twak Vikriti, Vicharchika, Shwitra, Transcriptomics, Proteomics, Ayurveda, Skin Disorders, Systems Biology, Molecular Correlates, Dosha Imbalance*

INTRODUCTION

Skin is the largest organ of the human body, accounting for nearly 16% of total body weight, and it serves as a barrier between the external environment and internal homeostasis. It regulates multiple functions including thermoregulation, immune defense, sensation, and synthesis of essential biomolecules such as vitamin D. More importantly, it is a highly visible organ that strongly influences self-image, aesthetics, and social interactions. Consequently, skin disorders often carry not only biomedical implications but also profound psychosocial and cultural dimensions.

In Ayurvedic medicine, disturbances of the skin are broadly categorized under the concept of *Twak Vikriti* (pathological changes in the skin). The classical Ayurvedic texts, including *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*, describe multiple varieties of *Kustha* (skin disorders), with *Vicharchika* and *Shwitra* given special attention due to their chronicity and impact on quality of life. *Vicharchika* manifests as itching (*kandu*), thickened lesions (*rukshata*), oozing (*srava*), and discoloration, often corresponding to conditions described today as eczema or dermatitis. *Shwitra*, on the other hand, is characterized by depigmented patches that may spread progressively, and is often equated with vitiligo in modern dermatology. Both conditions highlight the Ayurvedic understanding of doshic imbalance—particularly the roles of *Pitta* and *Kapha* in inflammatory responses and *Vata* in irregular pigmentation.

Modern biomedical research approaches these disorders through the lens of immunology, genetics, and molecular biology. In eczema, studies reveal overactivation of Th2-mediated immune responses, barrier dysfunction due to downregulation of filaggrin, and increased expression of cytokines such as IL-4 and IL-13. In vitiligo, autoimmune destruction of melanocytes, oxidative stress, and mitochondrial dysfunction are established hallmarks. Transcriptome profiling enables the identification of genes whose expression is altered in diseased tissues, while proteome profiling sheds light on dynamic protein networks that execute cellular functions. These high-throughput technologies allow a systems-level view of disease mechanisms that can be correlated with Ayurvedic frameworks of *dosha*, *dhatu*, and *srotas* disturbances.

Given the chronic, relapsing, and often refractory nature of these skin disorders, there is

growing interest in integrative models that combine Ayurveda’s holistic approaches with modern molecular insights. Such efforts not only help in validating traditional knowledge but also provide novel perspectives for biomarker discovery, therapeutic development, and personalized interventions. By bridging the descriptive language of Ayurveda with the quantitative data of omics sciences, researchers can uncover deeper molecular correlates of *Twak Vikriti*, thereby advancing dermatology toward a truly integrative paradigm.

LITERATURE REVIEW

Table 1. Ayurvedic Correlates and Molecular Pathways in Vicharchika (Eczema) and Shwitra (Vitiligo)

| Disorder | Ayurvedic Conceptualization | Molecular Correlates (Transcriptome/Proteome) |
|-----------------------------|---|---|
| Vicharchika (Eczema) | <i>Kapha-Pitta</i> predominance, itching (<i>kandu</i>), oozing (<i>srava</i>), thickening (<i>rukshata</i>) | Upregulation of IL-4, IL-13, TSLP; downregulation of FLG, LOR; elevated keratinocyte stress proteins (S100A7/8); altered ceramide metabolism |
| Shwitra (Vitiligo) | <i>Tridosha</i> imbalance with focus on <i>rasa</i> and <i>rakta dhatu dushti</i> ; depigmentation (<i>shwitra varna</i>) | Overexpression of IFNG, CXCL10, STAT1; downregulation of TYR, MITF; oxidative modifications of melanocyte proteins; reduced antioxidant enzymes |

AYURVEDIC UNDERSTANDING OF TWAK VIKRITI

Ayurveda attributes skin health to the harmonious balance of *doshas* (Vata, Pitta, Kapha), *dhatu*s (tissues), and *rasa-rakta dynamics* (blood and nutrient circulation). *Vicharchika* is characterized by *Kapha-Pitta predominance*, manifesting as itching (*kandu*), exudation (*srava*), and thickening (*rukshata*). *Shwitra*, on the other hand, is linked to *tridoshic imbalance* with a focus on impaired *rasa* and *rakta dhatu*, leading to discoloration and loss of pigmentation. Classical texts highlight improper diet, stress, and environmental triggers as etiological factors, which correspond remarkably with modern concepts of immune dysfunction, genetic susceptibility, and environmental stressors.

MODERN INSIGHTS INTO VICHARCHIKA (ECZEMA)

At the molecular level, eczema involves overactivation of Th2-driven immune pathways, elevated IL-4, IL-13, and dysregulated skin barrier proteins such as filaggrin. Transcriptome studies reveal upregulation of inflammatory cytokines and chemokines, while proteomic analyses demonstrate altered keratinocyte differentiation and lipid metabolism. These correspond to the Ayurvedic observation of disturbed *Kapha* (heaviness, oozing) and *Pitta* (inflammation, redness) dominance.

MODERN INSIGHTS INTO SHWITRA (VITILIGO)

Vitiligo is characterized by autoimmune destruction of melanocytes, oxidative stress, and dysregulated antioxidant defenses. Transcriptomic data indicate enhanced IFN- γ signaling, upregulation of CXCL10, and impaired melanogenesis-related genes such as TYR and MITF. Proteomic analyses highlight oxidative modifications of melanocyte proteins and impaired mitochondrial function. These findings align with *dosha* imbalance in *Shwitra*, where Vata contributes to irregular pigment distribution, Pitta to cellular damage, and Kapha depletion to loss of stability.

CONVERGENCE OF AYURVEDA AND MOLECULAR BIOLOGY

While Ayurveda uses qualitative descriptors rooted in holistic observation, systems biology provides quantitative maps of gene and protein alterations. Both approaches emphasize interconnectedness: Ayurveda through *tridosha* networks and modern science through signaling cascades. Integration of these paradigms creates opportunities for personalized medicine and preventive interventions.

MOLECULAR CORRELATES: TRANSCRIPTOME AND PROTEOME PROFILING

Table 2. Comparative Omics Insights for Vicharchika and Shwitra

| Feature | Vicharchika (Eczema) | Shwitra (Vitiligo) |
|------------------------|--|---|
| Dominant Immune Axis | Th2 skewing (IL-4, IL-13, TSLP) | IFN- γ driven cytotoxic axis (CXCL10, STAT1) |
| Key Structural Changes | Barrier dysfunction (filaggrin, loricrin loss) | Melanocyte apoptosis, adhesion protein loss |

| Feature | Vicharchika (Eczema) | Shwitra (Vitiligo) |
|----------------------|---|---|
| Oxidative Stress | Moderate increase, keratinocyte stress proteins | High increase, impaired catalase/SOD activity |
| Proteomic Highlights | Dysregulated ceramides, S100 proteins | Oxidized melanocyte proteins, mitochondrial dysfunction |

TRANSCRIPTOMIC SIGNATURES IN VICHARCHIKA

- Upregulation of IL4, IL13, and TSLP genes, driving Th2 immune bias.
- Downregulation of barrier proteins such as filaggrin (FLG) and loricrin (LOR).
- Enhanced expression of chemokines (CCL17, CCL22) facilitating immune cell infiltration.

These reflect inflammatory cascades (*Pitta*) and impaired barrier stability (*Kapha*).

PROTEOMIC LANDSCAPE OF VICHARCHIKA

- Elevated proteins involved in keratinocyte stress responses (S100A7, S100A8).
- Dysregulated ceramide metabolism affecting skin hydration and barrier.
- Increased oxidative stress proteins indicating immune activation.

TRANSCRIPTOMIC SIGNATURES IN SHWITRA

- Overexpression of IFNG, STAT1, and CXCL10 leading to cytotoxic T-cell recruitment.
- Downregulation of melanogenesis genes (TYR, TYRP1, MITF).
- Enhanced apoptosis-related transcripts in melanocytes.

PROTEOMIC LANDSCAPE OF SHWITRA

- Altered antioxidant enzymes (catalase, superoxide dismutase).
- Oxidatively modified melanocyte proteins, triggering autoimmune targeting.
- Reduced structural proteins maintaining melanocyte adhesion.

CHALLENGES

LIMITATIONS IN INTEGRATION

- Ayurveda emphasizes qualitative assessment, while omics rely on quantitative markers.

- Translating one system into another requires careful frameworks.
- Variability in Ayurvedic diagnosis based on practitioner interpretation introduces subjectivity.
- Omics datasets are expensive and require advanced computational infrastructure, limiting large-scale studies.

BIOLOGICAL COMPLEXITY

- Multifactorial etiologies of eczema and vitiligo complicate the mapping to single pathways.
- Heterogeneity in patient responses confounds reproducibility of transcriptomic/proteomic signatures.

SCOPE FOR INTEGRATIVE RESEARCH

SYSTEMS BIOLOGY MEETS AYURVEDA

By treating *dosha imbalance* as systems-level dysregulation, Ayurveda can provide context for interpreting omics signatures. For example, *Kapha vitiation* in Vicharchika may be studied through lipidomics, while *Pitta imbalance* in Shwitra can be mapped through oxidative stress markers.

BIOMARKER DISCOVERY

Integrative profiling can help discover biomarkers correlating with Ayurvedic subtypes (*prakriti-based phenotypes*). For instance, IL-13 upregulation in Vicharchika could serve as a marker for *Pitta-Kapha dominant prakriti* individuals.

THERAPEUTIC DEVELOPMENT

Ayurvedic formulations—herbal extracts, dietary regimens, *panchakarma* interventions—may be evaluated through omics readouts to reveal their molecular impact. This can bridge traditional claims with evidence-based validation.

FUTURE DIRECTIONS

PERSONALIZED MEDICINE

Integration of *prakriti* profiling with genomics may enable highly individualized treatment strategies, reflecting the Ayurveda principle of *swasthasya swasthya rakshanam* (maintenance of health).

OMICS-DRIVEN CLINICAL TRIALS

Longitudinal omics studies of patients undergoing Ayurvedic therapies could reveal mechanisms of action at the molecular level, fostering credibility and translational outcomes.

DIGITAL HEALTH AND AI

Machine learning models integrating Ayurvedic diagnostic parameters with omics datasets may enable predictive models for disease onset and treatment responses.

DISCUSSION

The dialogue between Ayurveda and modern biology is not merely metaphorical but functionally relevant. *Twak Vikriti* descriptions align with immune, oxidative, and structural perturbations uncovered by transcriptome and proteome profiling. Vicharchika's inflammatory phenotype resonates with cytokine overactivation, while Shwitra's depigmentation echoes melanocyte apoptosis and immune dysregulation. Such correspondences suggest that Ayurveda, though ancient, captured disease complexity in qualitative frameworks that modern science now quantifies.

CONCLUSION

The study of *Twak Vikriti*, particularly Vicharchika and Shwitra, through transcriptomic and proteomic lenses opens a new frontier in integrative medicine. By correlating molecular pathways with Ayurvedic principles of *dosha* imbalance, researchers can build comprehensive models of disease that respect both tradition and innovation. Despite challenges in integration and methodological disparities, the potential for discovery is immense. The convergence of ancient wisdom and cutting-edge omics technologies holds the promise of redefining diagnostics, therapeutics, and holistic care in dermatology.

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