

## “Conceptual and Molecular Understanding of Palitya: A Literary Synthesis of Brihat Trayi and Oxidative Stress Theory”

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### ABSTRACT

**Background:** Palitya (premature greying of hair) is described in Ayurveda as a Pitta-dominant Kshudraroga, attributed to Ushma-induced Paka (degeneration) of hair follicles. It represents a growing concern, with prevalence among young adults in the Indian subcontinent reported up to 41.4%. Modern research links this condition to oxidative stress, particularly hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) accumulation and reduced catalase activity. **Objective:** To synthesize the classical Ayurvedic Samprapti of Palitya from the Brihat Trayi with contemporary oxidative stress mechanisms, and to correlate Dosha-specific Lakshanas with current hair biology. **Methods:** A Tantrayukti-based qualitative literary review was conducted using primary Ayurvedic texts—Charaka Chikitsa Sthana 26, Sushruta Nidana Sthana 13, and Ashtanga Hridaya Uttara Sthana 20—along with their commentaries. These were integrated with modern literature (2009–2026) retrieved from scientific databases focusing on oxidative stress, melanocyte apoptosis, and catalase deficiency. **Results:** Pitta Vriddhi, triggered by factors such as Krodha and Atiushna Ahara, corresponds to elevated H<sub>2</sub>O<sub>2</sub> levels in hair follicles, leading to tyrosinase inhibition and impaired melanogenesis. The Ayurvedic concept of Ushma parallels antioxidant enzyme dysfunction, including catalase and glutathione peroxidase depletion. The process of Paka aligns with oxidative damage, lipid peroxidation, and melanocyte apoptosis, along with premature transition to the catagen phase. Dosha-specific features, such as dryness (Vataja) and yellowish discoloration (Pittaja), correlate with keratin alterations and melanin shifts. **Conclusion:** The “Ushma–Paka Theory” provides a conceptual bridge between Ayurvedic and molecular perspectives. Classical therapies like Nasya and Shiro Taila, utilizing antioxidant-rich herbs, may act through free radical scavenging and melanogenesis support, highlighting the integrative relevance of Ayurveda in Palitya management.

**Keywords:** Palitya, Premature Canities, Oxidative Stress, Catalase Deficiency, Brihat Trayi, Ushma Paka Theory, Bhrajak Pitta.

### INTRODUCTION

#### 1.1 Clinical Epidemiology and Disease Burden

Premature hair greying, clinically referred to as premature canities, is characterized by the loss of natural hair pigmentation before the age of 25 years in Asian populations. [1] It has emerged as a notable cosmetic and psychosocial concern, particularly in developing countries such as India. Recent cross-sectional studies conducted among medical students in Rajasthan have reported a prevalence as high as 41.4%, indicating a substantial burden in young adults. [2] Furthermore, a declining age of onset has been observed, with increasing incidence in individuals aged 16–20 years, especially within urban populations.[3]

Although premature greying does not directly impair physical health or result in hair loss, its psychological implications are significant. Affected individuals frequently report diminished self-esteem, social discomfort, and anxiety related to altered appearance. [4] In the socio-cultural context of the Indian subcontinent, grey hair is often associated with aging, which can lead to stigma and emotional distress among adolescents and young adults. Consequently, the condition represents not only a dermatological concern but also a psychosocial challenge that warrants comprehensive understanding.

#### 1.2 Ayurvedic Perspective: Palitya as Kshudraroga

In Ayurvedic literature, Palitya is classified as a Kshudraroga in Sushruta Nidana Sthana (13/37). [5] Other

classical texts provide additional contextual frameworks: Charaka Samhita describes it under Urdhwajatrugata Roga, while Ashtanga Hridaya categorizes it within Shiro Kapalagata Roga. [6,7] These classifications emphasize its localized manifestation in the cranial region while acknowledging systemic etiological factors.

The pathogenesis (Samprapti) of Palitya is primarily attributed to the vitiation of Pitta Dosha, often in association with Agni. Factors such as excessive physical exertion, mental stress, fatigue, and inappropriate dietary habits are believed to aggravate Pitta, which is then directed towards the head. This localized increase in metabolic heat (Ushma) leads to the premature “ripening” (Paka) of hair follicles, resulting in early loss of pigmentation.

Despite detailed classical descriptions, there remains a significant gap in correlating these Ayurvedic concepts with contemporary biomedical mechanisms. In particular, the relationship between Pitta-induced Paka and modern processes such as oxidative stress, melanocyte dysfunction, and apoptosis has not been systematically explored. Addressing this gap may provide a valuable integrative framework for understanding the pathogenesis of premature greying and for developing ayurvedic therapeutic strategies

## 2. Methodology

### 2.1 Tantrayukti-Based Literary Framework

The present study adopts a qualitative, integrative research design grounded in the Ayurvedic analytical principles of *Tantrayukti*. Specifically, the interpretative tools of *Arthapatti* (presumptive inference) and *Purvapaksha* (critical evaluation) were employed to systematically correlate classical Ayurvedic concepts with contemporary biomedical evidence. This framework enabled a structured synthesis of traditional *Samprapti* with modern molecular mechanisms.

#### Data Sources:

Classical Ayurvedic literature was reviewed through primary texts, including *Charaka Samhita (Chikitsa Sthana 26)*, *Sushruta Samhita (Nidana Sthana 13)*, and *Ashtanga Hridaya (Uttara Sthana 20)*, along with relevant commentaries. These sources were analyzed to extract detailed descriptions of *Palitya*, its etiological factors, and pathogenesis.

In parallel, a systematic search of modern scientific databases, including PubMed and PubMed Central (PMC), was conducted for studies published between 2009 and 2026. The search strategy incorporated keywords such as “oxidative stress,” “hair follicle apoptosis,” and “melanogenesis,” with particular emphasis on studies exploring the molecular basis of premature hair greying. [8]

#### Eligibility Criteria:

Studies were included if they provided direct or indirect insights into the pathophysiology of *Palitya* or described biochemical pathways related to melanogenesis, oxidative stress, or melanocyte degeneration.

Studies were excluded if they were limited exclusively to animal models without translational relevance, or if they focused on hair disorders unrelated to *Pitta*-dominant pathology, such as non-pigmentary alopecia.

#### Analytical Approach:

The extracted data were thematically analyzed and synthesized to identify conceptual parallels between Ayurvedic descriptions—such as *Pitta Vriddhi*, *Ushma*, and *Paka*—and modern mechanisms including reactive oxygen species accumulation, antioxidant enzyme deficiency, and melanocyte apoptosis.

## 3. Brihat Trayi Samprapti Analysis

### 3.1 Nidana Panchaka Synthesis

Table 1: Nidana Panchaka Synthesis of *Palitya* (Brihat Trayi Analysis)

Classical Text	Nidana (Etiological Factors)	Dosha Involvement	Affected Srotas / Site	Key Concept / Clinical Features
<i>Sushruta Nidana 13/37</i>	Krodha (anger), Atiushna Ahara (excessively hot/pungent diet)	Bhrajaka Pitta	Shiroromavaha Srotas	“Pitta Pacyate Kesha” – heat-induced degeneration of hair
<i>Ashtanga Hridaya Uttara 20/29–31</i>	Shoka (grief), Adibalapravrutta (constitutional factors)	Pitta–Vata	Kesha Koota (hair root complex)	Kharasparsha (roughness), Peeta (yellowish discoloration)

<b>Charaka Chikitsa</b> 26	Lavana and Katu Ahara (salty and pungent diet)	Pitta with Ushma	Romakoopa (hair follicles)	Concept of “hair ripening” ( <i>Paka</i> ) due to metabolic heat
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A comparative evaluation of the *Brihat Trayi* reveals a consistent emphasis on *Pitta*-dominant etiological factors in the pathogenesis of Palitya, with contributory roles of *Vata* in certain clinical presentations. The principal causative factors (*Nidana*) include psychological stressors such as anger (*Krodha*) and grief (*Shoka*), as well as dietary triggers like excessive intake of pungent (*Katu*) and salty (*Lavana*) foods. These factors lead to the aggravation of *Bhrajaka Pitta*, which is responsible for pigmentation processes.

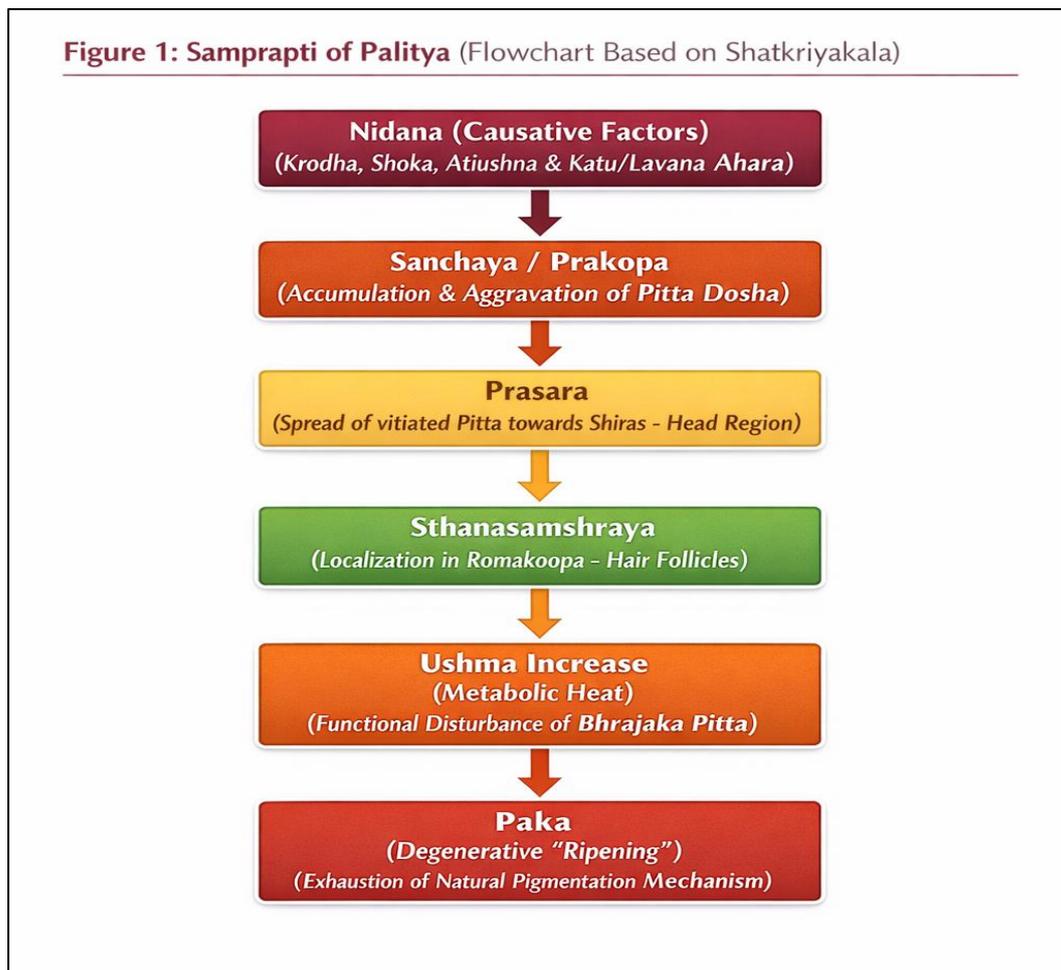
The pathological involvement primarily affects the *Shiroromavaha Srotas* and *Romakoopa* (hair follicle units), indicating a localized yet systemically initiated disorder. Classical descriptions highlight the concept of “*Pitta Pacyate Keshha*,” suggesting a heat-mediated transformation or degeneration of hair structure and color. Clinical features described in *Ashanga Hridaya*—such as rough texture (*Kharasparsha*) and yellowish discoloration (*Peeta*)—further support the role of *Pitta-Vata* interaction in disease manifestation.

Unlike inflammatory conditions where *Paka* denotes suppuration or tissue breakdown, in Palitya it signifies a gradual depletion of natural pigmentation due to sustained metabolic heat (*Ushma*). This conceptual distinction indicates a degenerative rather than inflammatory process, aligning with contemporary interpretations of pigment loss.<sup>[9,10]</sup>

### 3.2 Samprapti (Pathogenic Progression)

The progression of Palitya can be systematically understood through the *Shatkriyakala* model, illustrating the temporal evolution of disease:

Figure 1: Samprapti of Palitya (Flowchart Based on Shatkriyakala)



**Sanchaya and Prakopa (Accumulation and Aggravation):**

Initial accumulation of *Pitta Dosha* occurs due to dietary indiscretions and psychological stress, leading to its aggravation.

**Prasara (Spread):**

The aggravated *Pitta* disseminates through systemic channels and preferentially localizes in the cranial region (*Shiras*), owing to its affinity for sites of heat and metabolism.

**Sthanasamshraya (Localization):**

The vitiated *Pitta* localizes in the *Romakoopa* (hair follicles), where it interacts with local tissues and disrupts normal pigmentation mechanisms.

**Vyakti (Manifestation):**

Clinical manifestation occurs as premature greying of hair. The persistent *Ushma* leads to functional exhaustion of *Bhrajaka Pitta*, impairing melanin production and resulting in visible depigmentation. <sup>[11]</sup>

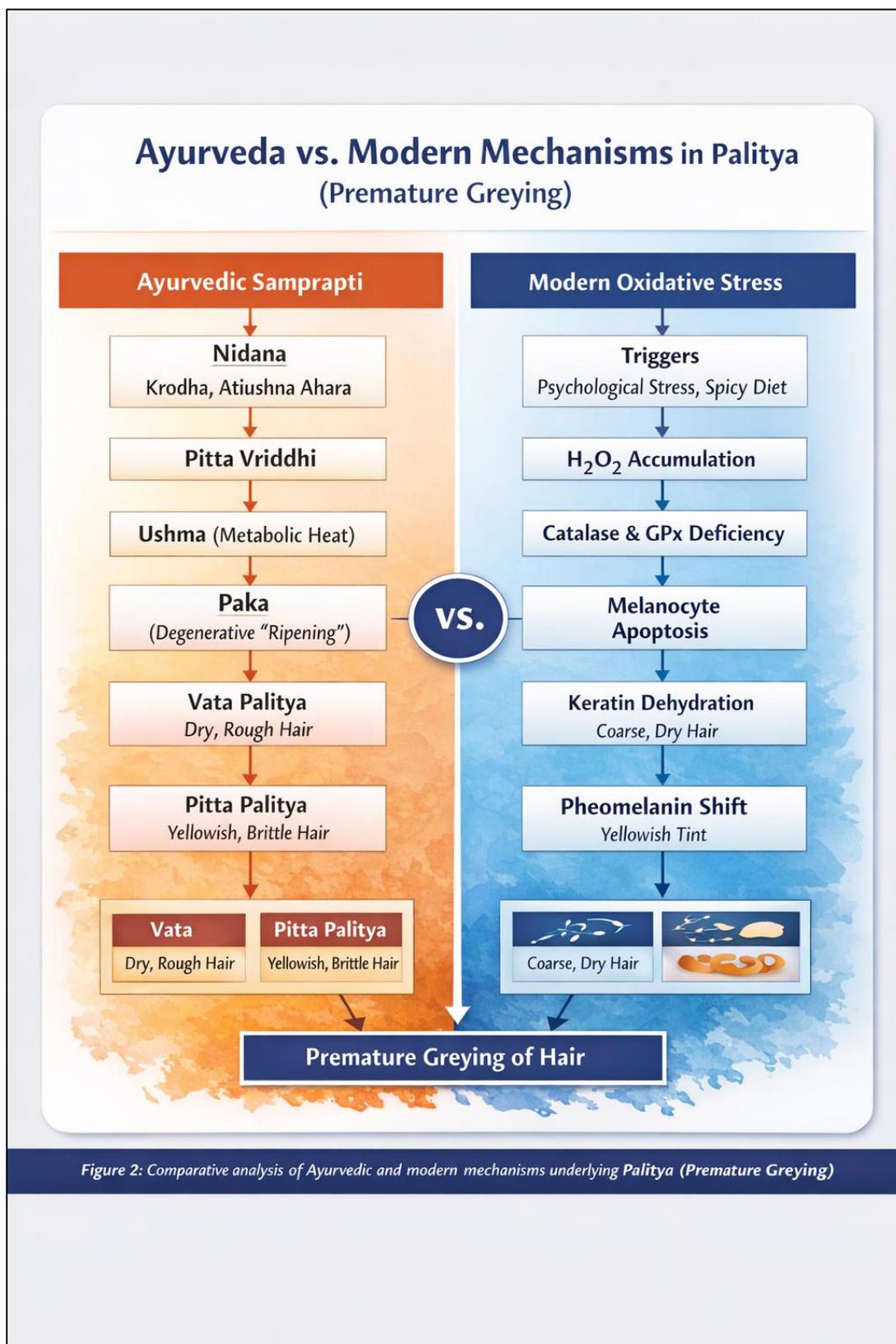
**4. Modern Oxidative Stress Correlates**

**4.1 Biochemical Pathway Mapping**

**Table No. 2: Biochemical Pathway Mapping**

Ayurvedic Event	Modern Mechanism	Key Evidence
<b>Pitta Vrudhi</b>	Accumulation	Millimolar concentrations in graying follicles. <sup>[12]</sup>
<b>Ushma in follicle</b>	Catalase	Compromised catalase activity fails to neutralize ROS. <sup>[13]</sup>
<b>Hair Paka</b>	Melanocyte Apoptosis	Lipid peroxides induce cell death in hair bulbs. <sup>[14]</sup>
<b>Dosha Lakshana</b>	Pheomelanin Shift	<i>Pitta</i> dominance aligns with yellow/red pigmentation. <sup>[15]</sup>

The internal "bleaching" of hair from accumulation is the modern molecular equivalent of the *Ayurvedic* "Pitta Pacyate". When antioxidant enzymes like catalase and glutathione peroxidase decrease, the resulting oxidative stress disrupts the structural integrity of the hair's DNA and lipids. <sup>[16]</sup>



#### 4.2 Dosha-Specific Validation

Vata Palitya:

Characterized by *Ruksha* (dryness) and *Kharasparsha* (roughness), correlating with keratin dehydration and the early onset of the catagen phase induced by oxidative stress. <sup>[17]</sup>

Pitta Palitya:

Manifests as *Peeta* (yellowish) hair and a burning scalp (*Shiradaha*), mirroring the shift toward pheomelanin and high follicular inflammation.

Kapha Palitya:

Hairs are *Sthula* (thick) and white, often associated with excessive sebum secretion which can sometimes harbor lipophilic fungi that exacerbate oxidative stress. <sup>[18]</sup>

## 5. Chikitsa Correlation: Classical to Molecular

### 5.1 Dravya Guna-Antioxidant Mapping

Table No. 3: Dravya Guna-Antioxidant Mapping

Dravya	Guna/Karma	Molecular Target	Palitya Action
Bhringraj	<i>Keshya, Ushna</i>	Apigenin, Luteolin	Promotes <i>Ranjanam</i> (dyeing/pigmentation).
Amalaki	<i>Rasayana, Sheeta</i>	Vitamin C, Polyphenols	Acts as a potent scavenger <sup>[19]</sup>
Guduchi	<i>Tridoshahara</i>	Tinospora antioxidants	Protects against cell death mechanisms.

Classical treatments like *Nasya* are considered among the best interventions because they directly target the *Urdhwajatrugata* (above the clavicle) region, potentially improving the bioavailability of antioxidant compounds in the hair bulb.

## 6. Discussion:

The synthesis of *Brihat Trayi* and contemporary molecular biology regarding *Palitya* reveals a profound epistemological convergence. By utilizing the *Tantrayukti* framework—specifically *Arthapatti* (presumption) and *Purvapaksha* (critical appraisal)—this review establishes that the Ayurvedic concept of *Ushma-mediated Paka* is the clinical equivalent of modern oxidative stress-induced melanocyte exhaustion.

### 6.1 Epistemological Bridge: The "Ushma Paka Theory"

The central finding of this synthesis is the "Ushma Paka Theory," which posits that the "ripening" of the hair described by *Sushruta* and *Charaka* refers to the internal bleaching of the hair shaft caused by millimolar concentrations of hydrogen peroxide ( $H_2O_2$ ). While *Paka* usually denotes inflammation or suppuration in other *Kshudrarogas*, its application in *Palitya* signifies a metabolic "burning out" of the pigmentary potential within the hair bulb. <sup>[20]</sup> This is supported by modern evidence showing that compromised catalase activity in the hair follicle fails to neutralize ROS, leading to the inactivation of the tyrosinase enzyme—the very "Bhrajak Pitta" responsible for hair color.

### 6.2 Validation of Dosha-Specific Lakshanas

A key strength of the Ayurvedic model is its ability to categorize premature graying into *Dosha*-specific phenotypes, which this review validates through biochemical correlates:

**Vata Palitya:** The classical description of *Ruksha* (dryness) and *Kharasparsha* (roughness) aligns with keratin dehydration and the premature onset of the catagen phase induced by lipid peroxides.

**Pitta Palitya:** The *Peeta* (yellowish) hue and *Shiradaha* (scalp burning) correlate with high follicular inflammation and a shift from eumelanin to pheomelanin production, a phenomenon observed in oxidative stress-prone scalps.

**Kapha Palitya:** The *Sthula* (thick) and *Snigdha* (unctuous) presentation suggests hypertrophic follicles, where initial eumelanin excess might lead to more rapid oxidative byproduct accumulation and subsequent sudden depletion.

### 6.3 Shatkriyakala and the Oxidative Cascade

The progression of *Palitya* through the *Shatkriyakala* (six stages of disease) provides a longitudinal view of pathogenesis that modern science often lacks. <sup>[21,22]</sup> The *Sanchaya* and *Prakopa* stages, triggered by *Krodha* (stress) and *Atiushna Ahara* (pungent diet), mirror the initial rise in follicular ROS. The *Sthanasamshraya* stage (localization in hair follicles) aligns with the depletion of follicular antioxidant reservoirs like glutathione and catalase. Finally, *Vyakti* (manifestation) represents the irreversible point of melanocyte apoptosis and DNA damage.

#### 6.4 Chikitsa as Molecular Intervention

The review of *Chikitsa* principles reveals that classical interventions are not merely symptomatic but are molecularly plausible. *Shiro Taila* and *Nasya* using *Amalaki* and *Bhringraj* deliver potent antioxidants directly to the hair bulb. *Amalaki*, rich in Vitamin C and polyphenols, acts as an scavenger, while *Bhringraj's* apigenin stimulates melanogenesis pathways. This validates the "superiority" of the *Nasya* methodology described in your synopsis as a high-bioavailability delivery system for the *Urdhwajatrugata* region.

#### 6.5 Limitations and Research Gaps

Despite the conceptual alignment, several gaps remain. First, the interpretation of *Paka* varies slightly between *Sushruta* and *Vagbhata*, requiring further philological reconciliation. Second, while modern studies show that stress-induced graying can be reversible, Ayurvedic texts typically describe *Palitya* as *Kashta-sadhya* (difficult to treat) once established, suggesting a need to investigate the "point of no return" in melanocyte apoptosis.<sup>[23]</sup> Finally, there is a lack of longitudinal clinical trials that quantify *Dhatu Parinama* (tissue transformation) using modern biomarkers like serum catalase alongside traditional *Dosha* assessments.

#### 7. Conclusion

The *Ushma Paka Theory* provides a robust interdisciplinary framework that connects Ayurvedic doctrine with modern biomedical science. By interpreting *Pitta-induced Paka* as a manifestation of oxidative melanocyte exhaustion, this model not only enhances the scientific understanding of premature greying but also supports the development of integrative, mechanism-based therapeutic strategies. Such an approach may be particularly valuable in addressing the increasing prevalence and psychosocial impact of *Palitya* in contemporary populations.

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