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GARBHA VARNA UTPATTI: AN ANALYTICAL STUDY OF AYURVEDA SIDDHANTA AND MODERN EMBRYOLOGY PERSPECTIVES

Dr. Singapure Shraddha Arvind*[1], Dr. Shruti Patil[2]

[1]Final Year PG Scholar, [2]Associate Professor,

Department of Prasuti Tantra and Stree Roga, Sri Sri College of Ayurvedic Science and Research, Bengaluru, Karnataka.

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***Corresponding Author**

Dr Singapure Shraddha Arvind

Final Year PG Scholar, Department of Prasuti Tantra and Stree Roga, Sri Sri College of Ayurvedic Science and Research, Bengaluru, Karnataka.

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ABSTRACT

Varna (skin color and complexion) is an important diagnostic and prognostic factor in Ayurveda, extending beyond pigmentation to radiance, lustre, and vitality. But with the concept of *Garbha Varna Utpatti* (origin of fetal skin color) described by *Acharya Charaka*, *Sushruta*, *Kashyapa*, and others, specifying and attributing skin color to *Panchamahabhuta*, *Shukra-Shonita*, maternal diet, regimen, psychological state, and hereditary factors. Classical treatises also highlight hereditary and spiritual determinants (*Beeja*, *Beejabhaga*, *Piturja*, *Matruja*, *Atmaja*, *Satmyaja bhava*). Contemporary science explains skin pigmentation primarily through melanogenesis, genetic regulation, embryological skin development, and environmental influences. This article attempts to understand Ayurveda concepts with embryology, biochemistry, and genetics, thereby presenting an integrative framework for understanding of fetal skin color and identify areas for further research. Understanding *Garbha Varna Utpatti* through both *Ayurveda* and modern science also provides opportunities for integrative approaches to maternal-fetal care (maternal care, fetal dermatology, and Ayurvedic nutrigenomics).

KEYWORDS: *Garbha Varna*, Embryology, Melanogenesis, *Ayurveda, Panchamahabhuta, Beeja*, Fetal complexion, Pigmentation, Genetic.

INTRODUCTION

Varna is a multifaceted concept in Ayurveda, encompassing color, complexion, texture, radiance (*Kanti*), and luster (*Prabha*). It is considered as a reflection of balanced *Dosha*, *Dhatu*, and *Agni*, and is used in *Ayu Pariksha* (prognostic evaluation) as mentioned in *Indriya Sthana*. Classical texts state that *Bala* (strength), *Varna*, *Ayushya (longetivity)* and *Sukha* (well-being) depend upon *Dhatusamyata*.

As the word Garbha Varna Utpatti has been used meaning Garbha (fetus), Varna (that which imparts color), Utpatti (that which has origin) along with references stating about speficity of skin color like Gaura, Shyama, Krishna varna, its pancha mahabhautika constitution, dietary factors that decides the skin color tone of fetus. References state it clarity that there is possibility of achieving desired color of the fetus with available references stating the changes in diet and lifestyle.

In modern biomedical science, skin color is determined by embryological development of skin, melanocyte distribution, melanin synthesis, genetic regulation, and environmental factors. Bridging Ayurveda with contemporary science can provide a holistic framework for understanding fetal skin color formation.

MATERIALS AND METHODS

The study utilized a narrative literature review design, integrating evidence from Ayurvedic classics with biomedical research to explore determinants of fetal complexion. Primary Ayurvedic sources consulted included *Charaka Samhita, Sushruta Samhita, Kashyapa Samhita,* and *Ashtanga Hridaya,* along with authoritative commentaries. Contemporary scientific literature was searched through PubMed, Scopus, and Google Scholar for studies related to embryology, melanogenesis, pigmentation genetics, and prenatal influences on fetal skin.

Findings from both systems were synthesized to highlight parallels, divergences, and opportunities for further integrative research.

Varna

As per *Shabdakalpadruma*

वर्ण + अच् धातु -> वर्णयतीति -> कुङ्कुमम् – हेमचन्द्रः

The one which imparts color is Varna, like that of Kumkuma.

वर्णयति प्रतिमां शुक्लादिवर्णां करोतीत्यर्थः

That which gives color like Shukla etc. is termed as Varna.

वर्णः शुक्लादिक्रिया

Varna is that which produces Shukladi Varna.

व्रियते इति । नित्। जातिः। सा कृवृजृषिद्रुगुपन्यनिस्वपिभ्यो वृ + च ब्राह्मणः शूद्रश्च । एषामुत्पत्यादिर्यथा। क्षत्रियो वैश्य

The term *Varna* also carries the meaning of "category" or "classification." In ancient times, society was organized into different groups based on profession, and these groups were referred to as *Varna*. The earliest reference to this system is found in the *Manu Smriti*, where society is described as being divided into four categories: *Brahmana*, *Kshatriya*, *Vaishya*, and *Shudra*. There are other terminologies related to word varna like Chaya, Prabha, Kanti.

When it comes to Varna Utpatti, references are available in Charaka Samhita Sharira Sthana, commentary available is of Gangadhara acharya.

न खलु केवलमेतदेव कर्म वर्णवैशेष्यकरं भवति|

अपि तु तेजोधातुरप्युदकान्तरिक्षधातुप्रायोऽवदातवर्णकरो भवति,

पृथिवीवायुधातुप्रायः कृष्णवर्णकरः, समसर्वधातुप्रायः श्यामवर्णकरः||१५||*Charaka.Shareera*.8/15.

The उत्पत्ति (origin) of वर्ण is described to occur during the process of गर्भनिर्माण (embryonic development). For the proper formation of गर्भ, the presence of आत्मा along with the पंचमहाभूत is essential. These महाभूत, through their various permutations and combinations, impart वर्ण (complexion/appearance) to the developing गर्भ.

- **Combination of अग्नि, जल, and आकाश महाभूत** → results in the formation of **श्वेत वर्ण (fair complexion)** in the गर्भ.
- **Combination of अग्नि, पृथ्वी, and वायु महाभूत** → results in the formation of **कृष्ण वर्ण (dark complexion)** in the गर्भ.
- **Combination of all mahabhuta** → results in the formation of **श्याम वर्ण (bluish black/ brown color)**

वर्णोत्पत्ति according to गांगाधर टीका[1]

गांगाधर explains that **तेजधातु** is mainly responsible for imparting **वर्ण** (complexion):

"तेजोधातुः वर्णकरः।"

During गर्भ formation, पंचमहाभूत combine with तेजधातु, and depending on their predominance along with मातृ आहार, different complexions are formed.

1. श्वेत वर्ण (Fair complexion)

- **Combination:** आप + आकाश + तेज
- आप is naturally शुक्ल, आकाश is विशद, when they unite with अव्यक्त वर्ण of तेज → श्वेत वर्ण arises.

2. कृष्ण वर्ण (Dark complexion)

- **Combination:** पृथ्वी + वायु + तेज
- पृथ्वी is कृष्ण in nature, वायु is रुक्ष, खर, चल. Together with तेज → कृष्ण वर्ण forms.

3. Other वर्ण Formations (based on तर-तम योग)

- **आप बहुल** + **तेज** → हरिताभ गौर वर्ण
- **आकाश बहुल** + **तेज** → पालाशाभ हरित वर्ण
- **पृथ्वी बहुल** + **तेज** → पक्क जाम्बु कृष्ण वर्ण
- **वायु बहुल** + **तेज** → नील/रुक्ष कृष्ण वर्ण
- **वायु** + **पृथ्वी बहुल** + **तेज** → कज्जल वर्ण
- **आकाश** + **पृथ्वी बहुल** + **तेज** → कृष्ण श्याम वर्ण

4. मिश्र वर्ण

- **Equal combination of all with तेज** → श्याम वर्ण (mixture of शुक्ल + कृष्ण)
  - **कृष्ण-श्याम** → पृथ्वी + तेज

- **गौर-श्याम** → आप + आकाश + तेज

5. Influence of मातृ आहार

- गर्भिणी's diet influences fetal वर्ण.
  - आप धातु predominance → गौर वर्ण
  - पृथ्वी धातु predominance → कृष्ण वर्ण
  - पृथ्वी + आकाश predominance → कृष्ण श्याम वर्ण
  - आप + आकाश predominance → गौर श्याम वर्ण

6. Association of mahabhutas in Netra Varna Utpatti

- If तेजधातु predominates excessively → अन्धत्व (blindness)
- रक्त अनुगत तेज → रक्ताक्ष
- वाय्वानुगत तेज → पिंगाक्ष
- श्लेष्मानुगत तेज → श्वेताक्ष
- वातानुगत तेज → विकृताक्ष

Charakacharya also quotes types of *Varna* as Prakruta and Vaikruta Varna. Krushna, Shyama, Shyama avadata, avadata varna falls under prakruta varna and Neela, Shyama, Tamra, Harita, Shukla varna falls under vaikruta varna.

Varna Utpatti (formation of skin color) occurs in different stages of life.
During *Garbha Avastha* (fetal stage), it is influenced both at the time of conception (*Garbha Dhana Kala*) and during the subsequent period of fetal development (*Garbha Vruddhi Kala*). After birth, Varna continues to be modulated through the natural progression of life stages, namely *Bala Avastha* (childhood), *Yauvana Avastha* (youth), and *Vruddha Avastha* (old age). These phases highlight that varna is not fixed at conception alone but undergoes dynamic changes throughout life, influenced by physiological, nutritional, and environmental factors.

According to Ayurveda embryology, the *Panchamahabhuta* play a vital role in determining *Garbhavarṇa* (fetal complexion).

Sushrutacharya specifically highlights *Tejodhatu* (Agni Mahabhuta) as the principal factor responsible for imparting color. The dominance and combination of different Mahabhutas lead to variations in skin color. For instance, predominance of *Teja* and *Jala* results in *Gaura Varna* (fair color), while combinations such as *Teja + Prithvi + Akasha* produce *Krishna–Shyama Varna* (bluish black), *Teja + Prithvi* leads to *Krishna Varna* (black), and *Teja + Jala + Akasha* gives rise to *Gaura Shyama Varna* (fair black). This demonstrates that skin color is not random but formed by elemental dominance, reflecting the intricate interplay of Mahabhutas during fetal development.[2]

According to Charakacharya, the *Mahabhutas* contributed by ***Shukra* (sperm) and *Shonita* (ovum)** in the *Garbhashaya* (uterus) determine the fetal complexion (*Varna*) based on their relative predominance. When *Agni*, *Jala*, and *Akasha* dominate, the fetus attains *Avadata Varna* (fair color). A combination of *Agni*, *Prithvi*, and *Vayu* results in *Krishna Varna* (black color), while an equal presence of all five *Mahabhutas* produces a brown color. This indicates that skin color is influenced by the elemental balance within the reproductive contributions of the parents.[3]

According to Harita, Garbha *Varna* is influenced by the predominance of *Doshas* in association with *Rakta*. When *Pitta* is dominant, it results in *Gaura Varna* (fair complexion). The combination of *Vata* and *Rakta* leads to *Krishna Varna* (bluish-black complexion), while *Kapha* with *Rakta* produces *Shyama Varna* (dark-brown complexion). A blend of *Pitta* and *Rakta* gives rise to *Pingala Varna*, characterized by a blackish-blue hue with a tinge of red. This explanation emphasizes the role of *Dosha–Rakta* interactions in determining the skin pigmentation pattern of the fetus.[4]

According **to *Ashtanga Sangraha Sharirasthana***, factors such as Shukra, Garbhini Ahara, Vihara, Mahabhuta, and Desha Kulanuvrutti play a vital role in determining the *Varna* of the fetus. The quality of **Shukra** significantly influences fetal complexion: Shukla (white, like Ghritamanda) leads to *Gaura Varna*, Tailabha quality results in *Krishna Varna*, and Madhvabha type corresponds to *Shyama Varna*.

Similarly, **maternal diet and lifestyle (Garbhini Ahara–Vihara)** contribute notably; intake of Dugdhadi, Madhura gana, and Jala Vihara is associated with *Gaura Varna*, while Tilanna and Vidahi foods result in *Krishna Varna*, and Mishrita Ahara corresponds to *Shyama Varna*.

Furthermore, **Desha and Kula** also exert their influence, where *Jati (kula)* and family lineage determine hereditary skin color patterns, and geographical or environmental factors (*Desha*) along with livelihood further modulate these outcomes. Collectively, these elements highlight an integrated view of heredity, maternal nutrition, lifestyle, and environment influencing skin color of the developing fetus.

In Ayurveda, the formation of **Netra Varna (eye color)** is described as being influenced by the predominance of specific Dhatus and Doshas during fetal development. When **Teja Dhatu** is predominant, it results in *Andhata* (blindness). Predominance of Rakta Dhatu gives rise to *Pingaksha* (reddish eyes), while Shleshma Anugata leads to *Shwethaksha* (whitish eyes). Similarly, Pitta Anugata is associated with *Pingaksha*, and Shleshma Anugata with *Shweta varna* of eyes. When Vata Anugata predominates, it causes *Vikrutaksha* (irregular or deformed eyes). This illustrates how the interplay of maternal diet, doshic influence, and dhatu predominance during gestation governs the specific coloration and health of the fetal eyes.

The **Shad Garbhakara Bhavas** play a vital role in determining the features of the fetus, including varna (complexion). Among these, *Atmaja* and *Satmyaja bhavas* are closely related to the manifestation of skin color and external traits. *Atmaja bhava* refers to the contribution of the Atma carrying impressions from previous births (purvajanma samskaras), along with the influence of trigunas and mahabhutas. This migrating Atma expresses various aspects in the fetus such as manas (mind), dharana (concentration), swara (voice), prerana (motivation), akruti (form), and varna (complexion). In contrast, *Satmyaja bhava* emphasizes the impact of the maternal diet and regimen during pregnancy, where ahara and vihara directly influence fetal development. This aspect particularly governs the matruja contribution to twak, thereby playing a significant role in determining the skin health and color of the fetus. In modern understanding, Satmyaja factors may be correlated with nutritional, genetic, and epigenetic influences, while Atmaja may reflect deeper hereditary and psychological determinants. Thus, both intrinsic (Atmaja) and extrinsic (Satmyaja) factors integrate to shape the fetus complexion and overall development.[5]

Skin color formation in the fetus is again a complex interplay of Matruja and Pitruja bhavas. Modern science explains that nuclear DNA from both parents determines pigmentation through multiple genes regulating melanin production, while maternal mitochondrial DNA

(37 genes) is passed only from mother and may indirectly influence skin via metabolic and epigenetic pathways. Epigenetic changes, maternal nutrition, and intrauterine environment further modulate gene expression. Though we don't have enough data which talks about gene expression for skin color but only for melanogenesis. Ayurveda describes Twak and varna as Matruja, highlighting the mother's role through *Ahara*, *Vihara*, and *Beeja-bhava*, while also acknowledging Pitruja bhava in contributing to overall genetic traits. Thus, though Ayurveda and modern science differ, both recognize that fetal skin color arises from combined parental genetic factors and maternal influences, influenced further by environmental and epigenetic modifications.

The role of ***Manasthiti* (mental state) of the *Garbhini* (pregnant woman)** influencing fetal development, as described in classical Ayurvedic texts like *Charaka Samhita* and *Ashtanga Hridaya*. The mother's thoughts and emotional state generate chemical signals such as hormones and enzymes that influence the fetus. These signals, along with the diet and regimen followed during pregnancy, affect the fetus by modulating the *Trigunas* (Satva, Raja, Tamas) and the *Panchamahabhutas* (five elemental principles). This interplay ultimately determines the *Varna* (complexion) and *Rupa* (form or physical features) of the child. Thus, the mother's psychological and physiological environment plays a crucial role in the holistic development of the fetus.

The role of *Ahara* (diet) and *Vihara* (lifestyle) of the *Garbhini* (pregnant woman) in influencing fetal development and maternal health. Ahara is categorized based on the stages of pregnancy, *Garbha-dhana kala* (pre-conception) and *Garbha-vriddhi kala* (gestation) while Vihara includes *Achara* (daily conduct) and *Vichara* (mental disposition).

Garbha Upaghathakara Bhavas (harmful influences on the fetus) also affect the varna of garbha. Specific dietary elements like *Kashaya rasa* (astringent taste) are linked to outcomes such as *Shyava varna* (dark complexion), while excessive *Amla rasa* (sour taste) is associated with skin disorders. Thus, appropriate Ahara and Vihara are essential for ensuring optimal fetal growth and preventing disease manifestations along with focusing on Garbha varna utpatti.[6]

The influence of ***Desha* (geographical region), *Kula* (lineage), and *Jati* (species or race)** on fetal characteristics and development. The *Desha* plays a significant role in determining *Varna* (color), with individuals from the northern region typically exhibiting *Gaur Varna* (fair

color), while those from the southern and central regions tend to have *Krishna Varna* (dark color) and *Shyama Varna* (dusky color), respectively. Migration between *Ushna* (hot) and *Sheeta* (cold) regions can also influence physiological traits. Additionally, the *Kula* and *Jati* contribute to inherited characteristics, reflecting the impact of genetic and environmental factors on the developing fetus.

After birth, although an individual's inherent constitution remains unchanged, it may be influenced by external factors such as atmospheric conditions, environmental changes, and pollution. Central to postnatal development is ***Jatharagni***, the digestive fire which plays a pivotal role in maintaining health and vitality. As emphasized by *Charakacharya* and *Vagbhatacharya*, Jatharagni governs essential physiological attributes including *Bala* (strength), *Varna* (complexion), *Swasthya* (health), *Utsaha* (enthusiasm), *Upachaya* (growth), *Prabha* (radiance), *Oja* (vital essence), and *Teja* (luster). Thus, the balance of Jatharagni is fundamental to sustaining well-being and optimizing bodily functions throughout life, here focusing on varna for both the healthy skin and bright fair skin color.

The dynamic interplay between *Jatharagni* (digestive fire), *Pancha Bhutagni* (metabolic fire of the five elements), and *Dhatuvagni* (tissue-level metabolic fire) in the transformation and nourishment of bodily tissues. The process begins with *Panchabhautika Ahara* food composed of the five elemental principles which is digested and assimilated into *Ahara Rasa* (nutritive essence). This essence undergoes further transformation through *Dhatuvagni*, forming *Dhatus* and *Upadhatus*, eventually leading to *Uttarottara Dhatu Poshana*. In the context of fetal development, this cascade plays a crucial role in determining *Varna* (skin color). The quality of Ahara especially its *Rasa* (taste), *Guna* (attributes), and elemental composition along with the efficiency of maternal Agni, influences the formation of *Rasa Dhatu*, which is the first tissue to nourish the fetus. If the maternal diet is rich in *Kashaya* (astringent) or *Tikta* (bitter) rasas, or if Agni is impaired, it may lead to dominance of *Vata* or *Pitta* doshas, potentially resulting in darker or uneven skin tone in the fetus. Conversely, a balanced diet with optimal Agni and predominance of *Madhura* (sweet) rasa supports healthy tissue formation and may contribute to a clearer, more radiant complexion. Thus, maternal metabolism and dietary choices are deeply intertwined with fetal tissue development and skin color expression.

In Ayurveda, diet (Ahara) holds foundational significance, as highlighted by **Sushrutacharya,** who emphasizes its role as the root (*moola*) for Bala (strength), varna

(complexion), and ojas (vital essence). Diet influences the balance of *dosha* (biological energies), *dhatu* (tissues), and *mala* (waste products); when doshas and dhatus are in equilibrium (*samya*), they promote enhanced strength and complexion. Complementing this, **Charakacharya's** framework of *Ahara Vidhi Vidhana* (dietary guidelines) underscores the importance of *snigdham ashniyat* (unctuousness) in achieving *varna prasaadana* (refined skin color).

***Dosha* dynamics**

- **Vata**: Among its five subtypes, *Udana vata* governs bala (strength), *swara* (voice), and varna (skin color).
- **Pitta**: Encompasses functions like *darshana* (vision), *pakti* (digestive capacity), *dehamardavata* (body heat), and *prabha* (luster). Its subtype *Bhrajjaka Pitta* specifically maintains skin color and warmth, residing in the *twak* (skin layer).
- **Kapha**: Characterized by *kapha prakriti lakshana* (traits of kapha constitution), it fosters a *sukumara avadata gatra* (smooth body) and *prasanna snigdha varna* (clear, unctuous color).

Mala (toxins) disrupts varna (skin color), making shodhana (purification) critical for their elimination.

Sara (essence) encompasses Rasa/Twak (plasma) and Rakta (blood), with classical texts noting that individuals possessing Shukra sara (seminal essence) exhibit a fair complexion.

Ojas, the vital essence of all dhatus, directly impacts varna: Varna bheda (skin discoloration) serves as an ojovyapat lakshana, Dushchaya (loss of complexion) indicates ojokshaya lakshana. When dhatu samyata is maintained, ojas quality improves, enhancing varna.

Vaya (age), post - 50 years bring hrasa (wrinkling) and shithilata (looseness), causing a loss of skin tightness and texture. Furthermore, Bala (strength) and varna are interlinked, as robust strength underpins a healthy complexion.

Skin: The skin, the largest organ and foundation of the integumentary system, exhibits intricate embryological development and structural complexity.

In Ayurveda literature, **Twacha** (skin) forms by the third month of intrauterine life, originating from shukra-shonita (the zygote), where metabolic transformation

(abhipachyamaana) generates seven layers (Saptha Kala) likened to cream forming on heated milk with Bhrajaka Pitta imparting luster.

❖ एवं प्रवृत्तस्य शुक्र शोणितस्य अभि प्रपच्च्यमानस्य क्षीरस्य एव सन्तानिकाः सप्त त्वचो भवन्ति। (सु.शा.४)

Saptha Kala refers to the seven distinct layers of the skin, each associated with specific anatomical structures. These include **Avabhasini, which imparts color to the skin** and corresponds to the Stratum corneum; Lohita, linked to the Stratum lucidum; Shwetha, associated with the Stratum granulosum; Tamra, connected to the Malphigian layer; Vedini, corresponding to the Papillary layer; Rohini, tied to the Reticular layer; and Mamsadhara, which relates to the Subcutaneous tissue. Each layer plays a role in the skin's structure and function, reflecting traditional or holistic perspectives on dermatological anatomy.

To understand the embryological development of the skin, it is essential to examine the key cells and structures that form its intricate architecture. **Keratinocytes** are the primary epidermal cells responsible for creating the skin's protective barrier through keratin production. **Fibroblasts**, found in the dermis, synthesize collagen and other extracellular matrix components to maintain structural integrity. **Appendages**—such as hair follicles, sweat glands, and sebaceous glands develop as specialized outgrowths of the skin, serving functions like thermoregulation and lubrication. **Melanocytes** migrate to the epidermis during development, producing melanin to shield against ultraviolet radiation. **Langerhans cells** are immune sentinels in the epidermis that detect and present antigens to initiate immune responses. Finally, **other structures** include sensory neurons (enabling touch perception), vascular networks (arterioles, venules, capillaries) for nutrient delivery and waste removal, lymphatics (supporting immune surveillance), and Merkel cells (specialized sensory receptors for light touch). Together, these components orchestrate the skin's dual roles as a physical barrier and a dynamic interface for sensation, immunity and skin color formation and expression.

Anatomically, the skin comprises the epidermis (superficial, protective, enabling vitamin D synthesis and pigmentation via melanocytes that produce melanin), dermis (beneath the epidermis, regulating temperature and sensation), and hypodermis (anchoring skin to muscles).

Signaling pathways are fundamental to the coordinated development of the skin, its appendages (e.g., hair follicles, sweat glands), and skin color. Key players include Wnt ligands, which drive cell proliferation and differentiation in the epidermis; P-63, a transcription factor critical for maintaining epithelial stem cells; the EDAR (ectodysplasin A receptor)-EDA (ectodysplasin A) axis, essential for appendage morphogenesis (e.g., hair follicle formation); the Notch receptor, which governs cell fate decisions and lateral inhibition to pattern skin structures; BMPs (bone morphogenetic proteins), which regulate growth, apoptosis, and differentiation in both epidermal and dermal layers; HOX transcription factors, which establish regional identity and patterning of the skin; and SHH (sonic hedgehog) ligand, which directs appendage development and spatial organization. For skin color, SOX-10 (regulates melanocyte development), MITF (the master regulator of melanogenesis), MSH (melanocyte-stimulating hormone activates melanin production via MC1R), and enzymes like tyrosine and tyrosinase (critical for melanin synthesis) collectively determine pigmentation. These interconnected pathways ensure the precise structural and functional maturation of the skin across its developmental and pigmentary dimensions.[7]

Embryologically, the epidermis derives from ectoderm, while most dermis arises from mesoderm (except facial/frontal scalp dermis, which stems from neural crest cells). Neural crest cells develop around 3 week of gestation from neural plate folding creates a groove and tube, with cells migrating laterally. Wnt signaling drives this migration, where dorso-lateral paths form melanocytes and ventero-medial paths yield glial cells and melanocytes. Somites (at week 3) condense mesoderm into dermatomyotome. Epidermal layers evolve from 4–5 weeks to 12 weeks of gestation, periderm forms early, sheds or becomes vernix caseosa by week 8, and terminal differentiation yields mature keratinocytes by week 12. During the second trimester, skin layers thicken; by 22–24 weeks, cornification occurs at the head, palms, and soles; 24–26 weeks bring a thickened stratum corneum; and mid-third-trimester skin resembles adult tissue.[8]

Developmental disruptions cause diseases: early fetal cell death is incompatible with life, while late fetal migration/mutation leads to mosaic disorders. Signaling pathways including Wnt, and tyrosinase regulate skin, appendage, and color formation, highlighting the nuanced biology of skin from embryogenesis to maturity.

To address the embryology of melanocytes and melanogenesis,

Melanin and Melanocyte Fundamentals: Melanin, the primary pigment in human skin, exists in two forms: eumelanin (brown/black, which protects against UV damage and reduces reactive oxygen species) and pheomelanin (yellow/orange, linked to UV-induced DNA damage in red-haired individuals). Specialized melanocytes synthesize and transfer melanin from melanosomes the organelles housing melanin to keratinocytes. Skin color variations arise from differences in melanin's amount, quality, distribution, and concentration, even though melanocyte numbers remain consistent across individuals.

Embryological Development of Melanocytes: Melanocytes originate from neural crest cells (NCCs). By 50 days of gestation, they localize to the hair follicle and epidermis (detectable via HMB45 immunostaining around 6–8 weeks), with fully pigmented melanocytes forming by 120 days.

Postnatally, melanization intensifies dermal melanocytes either migrate to the epidermis or undergo atrophy (failure causes dermal melanocytosis).

Dorso-lateral migration follows the path: NCC → melanoblast → melanocyte → interfollicular melanocyte in the epidermis a process exploited in vitiligo treatment to stimulate perifollicular repigmentation.

Melanosome Biology: Structure and Function: Melanosomes, termed the "hero of melanogenesis," develop in four stages.
Stage I: features round, non-melanized structures with minimal tyrosinase activity.
Stage II: transitions to oval shapes with high tyrosinase and a parallel fibrillar matrix, initiating melanin synthesis.
Stage III: shows full melanization
Stage IV: contains fully melanized granules with reduced tyrosinase.
Proteins like PMEL (amyloid) and tyrosinase regulate melanocyte and melanosome function, ensuring proper pigment production.

Epidermal Melanocyte Density and Distribution: Epidermal melanocyte density peaks early in fetal life (1000 cells/mm²) before rising to 3000 cells/mm² at 80–90 days, then stabilizing at 800–1500 cells/mm² in late fetal and adult skin. Density is highest at the face and genitals, lowest at the trunk and extremities, and chronic sun exposure doubles both melanocyte size and density. Each epidermal melanin unit comprises ~1 melanocyte to 10

keratinocytes, emphasizing the close relationship between melanocytes and keratinocytes in pigmentation.

Melanosome Transfer to Keratinocytes: Transfer occurs in Stage 4: melanocyte dendritic tips (via Rab-27-a and actin complexes) release melanosomes, which keratinocytes internalize through Keratinocyte Factor Protease Receptor (PAR-2). Mutations in this process cause partial albinism (e.g.Griscelli syndromes) with immunodeficiency. Within keratinocytes, melanosomes cluster (4–8 small ones in light skin, larger more in dark skin) and degrade via autophagy.

Molecular Pathways Regulating Melanogenesis: The MSH-MC1R-MITF pathway controls melanin type: Melanocortin-1 Receptor (MC1R), a G-protein-coupled receptor, determines eumelanin vs. pheomelanin production. Inactivated MC1R mutations lead to the red hair phenotype (fair skin, poor tanning, increased sunburn risk). α-MSH stimulates melanocytes, activating cyclic AMP → Protein Kinase A → CREB → melanin associated transcription factor (MITF), which drives melanogenesis gene expression.

UV-Induced Tanning: UV radiation (UVR) triggers tanning by increasing MITF and other factors (ACTH, β-endorphins, MSH, receptors), boosting melanogenesis. This adaptive response highlights the skin's ability to protect itself from environmental stressors, linking embryological development, cellular processes, and molecular pathways in maintaining skin pigmentation and health.

To understand skin color variations and their underlying mechanisms, we can organize the information into two main sections.

Classification of skin color types and factors driving skin color changes.

Classification of Skin Color Types[9]

Skin color is categorized using the Fitzpatrick scale (Types I–VI) and grouped by melanin content, reflecting genetic, geographic, and evolutionary adaptations.

Type I (Very Fair): Characterized by very pale skin, red/blond hair, and eyes. Individuals always burn in the sun and never tan. This type corresponds to "Very Light (Pale White)" skin, common in Northern Europeans, with very low melanin levels and a high risk of sunburn. It aligns with Fitzpatrick Skin Type I.

Type II (Fair): Features fair skin that burns easily but tans poorly. Linked to "Light (Fair)" skin, prevalent in Europeans, with low melanin. Sun exposure may cause burning, and tanning is minimal. This matches Fitzpatrick Skin Type II.

Type III (Medium): Described as medium-toned skin that sometimes experiences mild burns but tans uniformly. Associated with "Medium (Beige or Olive)" skin, found in Mediterranean, some Asian, and Hispanic populations. Melanin levels are moderate, leading to gradual tanning. It spans Fitzpatrick Skin Type III–IV.

Type IV (Olive or Light Brown): Characterized by olive or light brown skin that rarely burns and tans well. Corresponds to "Brown (Tan to Light Brown)" skin, common in Latin American, Middle Eastern, and Indian groups. Good natural sun protection and easy tanning result from higher melanin. This fits Fitzpatrick Skin Type IV–V.

Type V (Brown): Features brown skin that very rarely burns and tans very easily. Linked to darker skin tones, with high melanin content that provides strong sun resistance.

Type VI (Very Dark Brown or Black): Described as very dark brown or black skin that never burns and is deeply pigmented. This type corresponds to "Dark Brown to Black" skin, prevalent in African, Aboriginal, and Melanesian populations, with extremely high melanin levels that minimize sun damage. It aligns with Fitzpatrick Skin Type V–VI.

Factors Influencing Skin Color Changes: Skin color is not static; it responds to environmental, physiological, pathological, and cultural factors, primarily mediated by melanin.

Environmental Exposure: Sunlight is a key driver. Ultraviolet (UV) radiation stimulates melanocytes (cells that produce melanin), increasing melanin synthesis a process called "tanning." This adaptation helps protect the skin from UV damage.

Physiological Changes: Hormonal shifts, such as those during pregnancy or in conditions like Addison's disease, can alter melanin production, leading to hyperpigmentation (e.g., melasma or age spots). These changes are often temporary and resolve once hormone levels stabilize.

Pathological Conditions: Several disorders disrupt normal pigmentation:

Vitiligo: An autoimmune condition causing patchy loss of melanin, resulting in white patches.

Albinism: A genetic disorder characterized by a complete or partial absence of melanin, leading to very light skin, hair, and eyes.

Hyperpigmentation disorders: Conditions like post-inflammatory hyperpigmentation (darkening after inflammation) or jaundice (yellow tint from liver dysfunction) alter skin tone.

Cyanosis: A bluish tint caused by low blood oxygen levels, unrelated to melanin but still a notable color change.

Cultural or Cosmetic Factors: Human practices also impact skin color. Skin-lightening creams, tanning beds, and artificial tanning methods (e.g., spray tans) modify pigmentation temporarily or permanently. Makeup can mask or enhance natural skin tone, further influencing perceived color.

These classifications and factors highlight the complex interplay of genetics, environment, and lifestyle in shaping skin color, underscoring melanin's central role in both diversity and adaptability.

DISCCUSION

Regimen for Yathecha Varna of Putra: Regimens impacting a fetal skin color (Yathecha putra varna), covering maternal diet (during pregnancy and lactation) and its effect on baby skin color can be linked to genes, melanosomes, and melanin type. It also addresses individual diet's role on skin color, prakruti specific diets for dosha - dhatu balance, purva janmakruta karma (past actions) and skin disease manifestation, and the correlation between Ayurvedic and contemporary science on skin color, eye color, and Netra Varna Utpatti (eye color formation).

Pancha Mahabhuta & Melanogenesis: The five elements (Pancha Mahabhuta) govern melanogenesis: Prithvi (Earth) provides structural stability and supports melanin storage in keratinocytes; Ap (Water) maintains moisture, plasma, and smoothness, aiding melanin diffusion in keratinocytes via cytoplasmic transfer; Tejas (Fire) drives digestion, transformation, color, and luster, representing Bhranjaka Pitta (equivalent to tyrosinase activity) that controls melanin synthesis; Vayu (Air) facilitates melanosome movement to upper skin layers; and Akasha (Ether) offers space for skin layers and enables melanin distribution across the skin surface.

Tejas Mahabhuta: Core of Melanogenesis: Tejas is the core of melanogenesis, driving the conversion of tyrosine to melanin. Ayurvedic texts note Bhrajaka Pitta (aligned with Tejas) is Tejomaya (fiery) and responsible for skin color. Skin (Twak) is a product of Rasa Dhatu and contains all Mahabhutas, reflected in properties like softness (Ap), structure (Prithvi), color (Tejas), nutrient movement (Vayu), and space (Akasha). Melanogenesis is the physical expression of Tejas through Bhranjaka Pitta, supported by the structural, transport, nourishing, and spatial functions of other Mahabhutas.

So a balanced stat of pitta is important considering skin color formation

Tejas-Agni-Pitta-Skin color: Gaura varna- teja mahabhuta pradhanata

Tejas drives tyrosinase activity and when tyrosinase is increased, melanin is increased causing dark skin color. Balancing this is also important in imparting good skin color.

Jala mahahuta pradhanata: imparts snigdhata to skin and improves skin health

Factors Responsible for Skin Color Formation: Key factors forming skin color

1. Melanin (primary determinant): Produced by melanocytes in the basal epidermis, with eumelanin (brown/black, dominant in darker skin) and pheomelanin (red/yellow, more in fair skin/red hair). Content and distribution set base tone, and melanin protects against UV radiation.

2. Genetic Factors: Genes regulate melanocyte activity, melanin production, and type (e.g., MC1R affects melanin type; SLC24A5, TYR, OCA2, ASIP involved in synthesis). Inherited from both parents and vary by ethnicity.

3. Sunlight/UV Radiation: Stimulates melanogenesis (tanning) but causes burning or hyperpigmentation/sun spots with chronic exposure.

4. Hormonal Influences: Estrogen/progesterone increase melanin (e.g., pregnancy - related melasma); ACTH/MSH stimulate production (seen in Addison's disease).

5. Biochemical Factors: Tyrosinase (essential for melanin synthesis from tyrosine); deficiency causes albinism; copper is a tyrosinase cofactor.

6. Hemoglobin and Blood Flow: Oxygenated hemoglobin makes skin pinkish/reddish; poor oxygenation causes cyanosis (bluish tint); increased flow (blushing/inflammation) alters temporary color.

7. Carotene: Yellow - orange pigment from foods (carrots, sweet potatoes) accumulates in the stratum corneum/fatty areas, giving a yellowish hue.

8. Pathological Factors: Vitiligo (melanocyte loss, depigmented patches), hyperpigmentation (post - inflammatory darkening), hypopigmentation (pitryasis alba/albinism).

How all these can be related with Mahabhutas and skin color expression in baby?

By Understanding,

- **Effect of Rasa on Skin**

Ayurvedic texts detail how rasa affect skin:

- Madhur: Enhances skin luster

- Amla: Excess causes eruptions

- Lavana: Excess accelerates swelling, blood stagnation, ulcers
- Katu: Reduces oiliness but excess causes inflammation
- Tikta: Balances inflammation (best for skin diseases; excess increases dryness
- Kashaya: Excess causes tanning, lentils/broccoli have carotenoids (like lutein) that create a tanned appearance.

Ayurveda approaches skin color through a holistic lens, integrating foundational principles like the Panchamahabhuta (five elements) composition of an individual's prakruti (constitution), the quality of shukra shonita (semen and ovum), and maternal influences such as diet (matruja ahara-vihara, or garbhini paricharya), mental state (atmaj and satmyaj bhava), and emotional stability (matruja mana sthithi). Additional factors like place (desha), family lineage (kula), nutritional therapies (Rasayana), and pre-existing diseases (roga) also shape outcomes for example, excessive *amla rasa* (sour taste) in the mother may cause skin diseases in the child, while *kashaya rasa* (astringent taste) can impart a *shyava varna* (dark complexion).

As per sushrutacharya reference: Teja mahabhuta is present in all types of Garbha varnotpatti karana being a vital compenent of bhrajaka pitta which resides in skin, undergoes changes due to the action of dravyas, with their tara tamata of mahabhutas and expression of Garbha varna happens.

Gurvadi gunas and panchabhautika relationship to understand panchabhautika constitution of Dravya[10]

Table no. 1: Gurvadi Gunas and Panchamahabhuta Constitution with examples.

Guna (Quality)	Lakshana / Property	Panchabhautika Constitution	Function (Karma)	Examples of drugs conataining
1. Guru (Heaviness)	Heavy, increases bulk	Prithvi + Jala	Brimhana (nourishment, stability)	Masha, Dadhi (curd), Meat
2. Laghu (Lightness)	Light, easily digestible	Vayu + Akasha	Deepana, Pachana (improves digestion, reduces heaviness)	Yava, Mudga, Laja
3. Sheeta (Coldness)	Cooling, soothing	Jala + Vayu	Stambhana (checks bleeding, cooling, stabilizing)	Chandana, Usheera
4. Ushna (Hotness)	Heat producing	Agni	Pachana, Deepana (digestion, metabolism)	Pippali, Shunthi
5. Snigdha (Unctuousness)	Smooth, oily, soft	Jala	Snehana (lubrication, nourishment)	Ghrita, Taila

6. Ruksha (Dryness)	Dry, rough	Vayu	Shoshana (absorbs moisture, dries)	Yava, Kulattha
7. Manda (Dullness, Slow)	Mild, slow activity	Prithvi + Jala	Shamana (subsides, stabilizes functions)	Payasa, Dugdha
8. Tikshna (Sharpness)	Intense, penetrative	Agni	Shodhana, Pachana (clears obstruction, sharpens digestion)	Maricha, Hingu
9. Sthira (Stability)	Firm, stable	Prithvi	Dharana (provides stability, prevents mobility)	Til, Mudga
10. Sara (Mobility)	Flowing, spreading	Vayu + Jala	Pravartana (circulation, movement)	Eranda taila
11. Mridu (Softness)	Soft, tender	Jala + Akasha	Soumya guna – provides softness, soothing	Draksha, Ksheera
12. Kathina (Hardness)	Hard, rigid	Prithvi	Sthirikarana (hardening, solidifying)	Ashma, Shilajatu
13. Vishada (Clarity)	Clear, non-slimy	Vayu + Agni + Akasha	Shoshana, removes turbidity	Musta, Ushira
14. Picchila (Sliminess)	Slimy, sticky	Jala + Prithvi	Sandhana (union, binding, healing)	Ghrita, Ikshu rasa
15. Slakshna (Smoothness)	Smooth, slippery	Jala	Sneha, softness	Tila taila, Ksheera
16. Khara (Roughness)	Rough, coarse	Vayu	Rukshana (abrasive, scrapping)	Yava, Kulattha
17. Sukshma (Subtle/Fineness)	Minute, penetrates channels	Vayu + Agni + Akasha	Vyavayi (quick spreading, subtle action)	Hingu, Trikatu
18. Sthula (Bulkiness)	Big, bulky	Prithvi	Brimhana (increase of body bulk)	Masha, Dadhi
19. Sandra (Density/Solidity)	Dense, compact	Prithvi	Stambhana (holding together, compactness)	Guda, Mamsa
20. Drava (Liquidity)	Liquid, flowing	Jala	Vilayana (dissolves, liquefies, facilitates circulation)	Dugdha, Jala

Rasayana, a rejuvenative practice, is pivotal in promoting longevity, strength, intelligence, and delayed aging, as emphasized in classical texts. Its benefits extend to enhancing color, antioxidant, anti-inflammatory action, moisturizing tissues, purifying blood (rakta prasadaka), and supporting reproductive health.

❖ दीर्घमायुः स्मृतिं मेधामारोग्यं तरुणंवयः| **प्रभावर्णस्व**रौदार्यं देहेन्द्रियबलं परम् ॥७॥

वाक्सिद्धिं प्र**णतिंकान्तिं** लभते ना रसायनात्। लाभोपायो हि शस्तानां रसादीनां रसायनम्।। ८

Nalikela udaka

Kanti vardhaka

Rakta prasadaka, Shodhaka Dravya

Varnya gana

Table no.2: Varnya Gana Dravya and Panchamahabhuta Constitution with examples.

Sanskrit Name	Rasa, Guna, Veerya, Vipaka, Prabhava	Panchamahabhautika pradhanyata
Chandana	Rasa (Taste): Madhura, Tikta Guna (Qualities): Laghu, Rukṣa Virya (Potency): Shita Vipaka (Post-digestive effect): Madhura	Agni, vayu, akasha, Sheeta: jala+ Prithvi
Tunga	Rasa: Tikta, Kaṣhaya Guna: Laghu, Rukṣa Vīrya: Shita Vipāka: Katu	Jala pradhanya, Prithvi, Agni, vayu
Padmaka	Rasa: Kashaya, Madhura Guna: Laghu, Rukṣa Virya: Shita Vipaka: Kaṭu	Jala, Prithvi, teja, vayu
Ushira	Rasa: Tikta, Madhura Guna: Laghu, Rukṣa Virya: Shita Vipaka: Madhura	Vayu pradhana, teja, jala prithvi
Madhuka	Rasa (Taste): Madhura Guṇa (Qualities): Guru, Snigdha Virya (Potency): Shita Vipaka (Post-digestive effect): Madhura	Jala, Prithvi,
Manjistha	Rasa: Tikta, Kashaya, Madhura (slight) Guṇa: Guru, Ruksha Virya: Uṣṇa Vipaka: Kaṭu	Jala, Prithvi, Teja, vayu
Sariva	Rasa: Madhura, Tikta Guṇa: Guru, Snigdha Virya: Shita Vipaka: Madhura	Jala, Prithvi
Sita (white durva)	Madhura Kashaya rasa Laghu guna Madhura vipaka Sheeta veerya	Jala, Prithvi, Teja, Vayu

Same can be understood for, Jeevaniya gana, Prajasthapana gana, Rasayana and vajeekarana gana and the Varna Utpatti- Panchamaha Bhautika composition of Dravya, these concepts can be understood and applied in clinical practice for Yathecha Putra Varna Utpatti.

Hombale Rasayana: Traditional practices like Hombale Rasayana exemplify this integration: a specialized formulation administered to pregnant women during the Pushya nakshatra (a favorable astrological period), it aims to prevent miscarriage, nourish the womb, strengthen pregnancy, and bestow a good color to the fetus. Given in the 3rd, 5th, 7th, and 9th months, it requires adhering to a Satvic (pure) diet, especially milk - based foods.

Key ingredients include Hombale coconut inflorescence (with kashaya rasa to prevent bleeding), Ksheera (cow's milk, rich in nutrients to promote fetal growth and balance vata-pitta), Badam (almonds, balancing vata and providing folate to reduce miscarriage and autism risks), Red rock candy (relieving nausea and vomiting while balancing kapha-pitta), Raisins (calming the mind and preventing urinary tract infections), Dates (preventing anemia and maintaining healthy weight), and Figs (alleviating morning sickness and constipation). These are tailored to the mother's prakruti and health status, often combined with other Ayurvedic medicines.

Relation of hombale ingredients and their panchabhautika constitution: possible skin color

Narikela: Jala+Prithvi

Ksheera: Swadu, sheeta, mrudu, snigdha, bahala, shlakshna, picchila, guru, manda, Prasanna: Jala pradhanya+ akash+ agni+ Prithvi

Almonds: J +P+ T

Khanda sharkara: Jala+ Prithvi

Mrudwika: Jala + Prithvi

Kharjura: Jala + Vayu+ Prithvi (as does Deepana: teja mahabhuta?)

Anjir: Jala+ Prithvi

Skin color (varna) also holds diagnostic value in Ayurveda, serving as a tool for Darshana Pariksha (visual examination) to identify Arishta lakshanas (ominous signs) indicative of underlying imbalances. This multifaceted approach rooted in constitutional theory, nutritional science, and traditional wisdom highlights Ayurveda's commitment to nurturing maternal and fetal well being through targeted, holistic interventions.

It is also told in ayurveda classics that Garbha upaghatakara bhavas, not following garbhini paricharya causes Garbha varna vikruti as a type of Garbhanga Vikruti.[11]

Garbhanga Paricharya[12]: Garbhini paricharya (pregnant woman's regimen) tailors dietary and therapeutic practices across pregnancy months to nurture fetal skin development, leveraging principles of dhatu (tissue) nourishment, dosha balance, and complexion enhancing (varnya) herbs.

Prathama Masa

non - medicated milk (Charaka)
sweet/cold/liquid diets (Sushruta)
Ksheera (milk) with herbs like Salparni and Palasa (Vagbhata) promote Pitta balance and tissue nourishment, laying the groundwork for early skin formation, these herbs are specifically varnya (fair color – enhancing being teja and jala mahabhuta predominant also exhibit anti tyrosinase activity).

Dwitiya masa: Milk medicated with Madhura Rasa (sweet - tasting) drugs boosts Rakta Dhatu (blood tissue), essential for a glowing, healthy fetal skin and gaura varna being more jala mahabhuta predominant and supporting tissue development.

Tritiya masa: Milk with honey and Ghrita (clarified butter) or Shashtika rice cooked in milk is used. Honey and Ghrita act as Rasayana (rejuvenating agents) and varnya, improving the fetus's complexion, skin color, strength, and skin texture, while Shashtika rice provides nourishment and cooling effects to aid Pitta balance.

Chaturtha masa: During the fourth month, butter (Navneet), milk with butter, or meat of wild animals is recommended. Butter, rich in healthy fats, enhances skin hydration and luster, and meat supplies protein for structural development (including skin and hair growth).

Panchama masa: Ghrita (ghee) with milk or meat is given. Ghrita improves Ojas (vital essence), directly linked to skin glow (Sarpi Varna), and fat/protein support collagen and dermal matrix development.

Shashtam masa: Medicated Ghrita or Gokshura Ghrita is used. Gokshura is a balya (strengthening) and varnya herb, enhancing the fetus's color, strength, and moisture retention in the skin.

Saptama masa: Ghrita with the Prithakparnyadi group of drugs is employed. These herbs offer cooling, rejuvenating, and detoxifying effects, purifying Rakta (blood) and Pitta to promote clear, bright skin.

Ashtama masa: Ksheera Yavagu (rice porridge) with ghee or Asthapana and Anuvasana Basti (medicated enemas) are utilized. Yavagu and ghee provide nourishment, while Basti clears toxins (especially from Apana Vata), improving nutrient supply to the fetus and indirectly enhancing skin tone.

Navama masa: Oil Basti (oil - based enema) and Yoni Pichu (vaginal tampon) ensure smooth delivery and balance Vata.

Complementary to these monthly regimens, key dietary factors like

Ghee (rich in omega - 3/DHA, fat - soluble vitamins) support fetal brain, skin, and retina development.

Amla (high in vitamin C/polyphenols) protects against oxidative stress and promotes melanin formation.

Navaneeta butter (providing Snigdha/Sangrahi qualities) aids placental stability and enhance skin tone.

Madhura Dravya (sweet substances) build Ojas, nourish dhatus, and balance Kapha for robust fetal growth and has varnya effect.

Varnya Gana Dravyas (e.g., Chandana, Tunga, Padmaka) cool, soothe, and purify the blood to enhance skin color.

Jeevaniya Gana Dravyas (e.g., Jeevaka, Rishabhaka) build Rasa/Rakta Dhatu to support fetal growth and skin vitality.

Traditional foods, Panchabhautika composition and possible fetal skin color

Saffron + milk: Katu, tikta rasa, ushna veerya, snigdha guns, katu vipaka hebce mixed with ksheera and administered. Jala, Teja, Prithvi mahabhuta: imparts gaura varna

Coconut (narikela): Jala pradhana

Grapes: Jala pradhana prithvi

Almonds: Teja pradhana Prithvi (skin - nourishing fats/vitamins) further reinforce these benefits, illustrating Ayurveda's integrated approach to fostering healthy fetal skin through targeted nutrition and therapeutics.

Amalaki: Pancharasa, Jala, Prithvi mahabhuta pradhana, best antioxidant

Ghruta: Jala pradhana, teja, prithvi

Ksheera: Jala pradhana, prithvi

Kadali: Jala+ Prithvi mahabhuta pradhana

Paneer (kilata)

Funnel seeds (mishreya): Teja, Vayu,

Oranges (Naranga): Jala, Prithvi mahabhuta pradhana

Panchabhautika pradhanyata derived from rasa, guna, veerya, vipaka of any drug should make it easy understand the possibly of skin color expression

Bhrajaka pitta: Teja mahabhuta is there to carry the process for transformation, metabolism comes along with mahabhutas of dravyas and forms the skin color.

CONCLUSION

The present review is an attempt to understand the Ayurvedic concepts of *Garbha Varna Utpatti* in the light of contemporary scientific knowledge. At present, the Ayurvedic explanation of *Varna Utpatti* and the modern understanding of fetal skin colour development do not fully align. This highlights the need for a deeper understanding of both systems and further scientific investigation. Future research may include ethically designed animal studies and observational studies during antenatal care to document maternal practices, *Garbhini Paricharya*, and fetal outcomes. Specific Ayurveda *Dravyas* traditionally associated with *Varna* require scientific evaluation to determine their effects, if any, on fetal complexion and to establish their maternal and fetal safety, including potential teratogenic effects.

Such evidence-based research may help bridge the gap between classical Ayurvedic concepts and contemporary science, while supporting the safe and responsible application of Ayurveda in antenatal care.

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