



Review Article

Volume 15 Issue 06

June 2026

THE ECOLOGICAL BASIS OF CHARAKOKTA DESHA BHEDA: AN
ECOPHARMACOGNOSTICAL REVIEW ON THE HABITAT-DRIVEN VARIATIONS OF
DANTI MOOLA (*BALIOSPERMUM MONTANUM MUELL ARG. ROOTS*)

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Abstract

Background: In Ayurvedic pharmacology (Dravya Guna Vijnana), the therapeutic behaviour of a drug is not a static attribute defined solely by its genetic profile; it is dynamically modified by its geographical habitat (Desha). Modern pharmacopeial monographs routinely standardize medicinal plants based only on botanical taxonomy and macro-morphology, often ignoring the concept of “Desha Sampat” (ecological excellence). Danti (*Baliospermum montanum Muell Arg.*) is a Tikshna Virechana (drastic purgative) drug whose phytochemistry is highly sensitive to environmental factors. Sourcing it indiscriminately can lead to unpredictable therapeutic outcomes or severe gastrointestinal toxicity.

Objective: This review provides a comprehensive analysis mapping the classical concepts of Anupa (marshy), Jangala (arid) and Sadharana (temperate) Desha to contemporary principles of Eco pharmacognosy, establishing how these distinct microclimates regulate the structural anatomy, cellular deposition, and secondary metabolomics of Danti Moola.

Methods: A systematic exploration of classical Ayurvedic literature (Brihatrayi, Laghutrayi, and major Nighantus) along with modern electronic databases (PubMed, Scopus, Google Scholar) was executed. We cross-referenced classical descriptions of land classification with

modern plant physiology literature focusing on environmental stress-induced secondary metabolites in the *Euphorbiaceae* family.

Results: Textual analysis reveals that Jangala Desha is dominant in Agni and Vayu Mahabhuta. This matches modern definitions of arid, high-solar, and water-stressed ecosystems. These stressors up-regulate the shikimate, phenylpropanoid, and terpenoid pathways, concentrating irritant phorbol esters (e.g., montanin, baliospermin) and protective polyphenols. Conversely, Anupa Desha (Jala and Prithvi dominant) acts as a low-stress, hydromorphic ecosystem that favours primary vegetative growth and cellular dilatation, leading to a diluted secondary metabolite profile. Sadharana Desha functions as a balanced metabolic baseline.

Conclusion: Ancient Desha Pariksha is a functional precursor to modern Eco pharmacognosy. This review details how habitat-driven variations directly alter the clinical safety and efficacy of Danti, providing a strong scientific rationale for incorporating strict geographical criteria into modern herbal raw material standardization.

Keywords: *Baliospermum Montanum* Muell Arg., Charaka Samhita, Danti, Desha Bheda, Eco pharmacognosy, Phorbol Esters, Phenotypic Plasticity.

1. Introduction

The core objective of Dravya Guna Vijnana (Ayurvedic pharmacology) is to understand a drug's systemic action (Karma) through its discernible attributes (Rasa Panchaka): Rasa (taste), Guna (physicochemical properties), Veerya (potency), Vipaka (post-digestive trait), and Prabhava (specific action). However, classical Ayurveda emphasizes that these five attributes are not entirely fixed within a plant's genome. Acharya Charaka establishes that the therapeutic efficacy of any plant is a variable expression heavily modified by four core factors: Desha (habitat), Kala (chronobiological/seasonal timing), Guna (enrichment of potency), and Bhajana (processing and storage safeguards)^[1]. Among these, Desha represents the primary baseline factor that shapes the plant's initial development.

In the modern globalized herbal market, commercial collections of crude drugs are routinely carried out without considering their original habitat. Provided a sample matches the basic genus and species criteria, it is introduced into the manufacturing stream. This approach ignores phenotypic plasticity the mechanism by which a single plant genotype alters its

morphology and internal anatomy in response to surrounding environmental changes and chemo typic variation, which alters chemical compounds based on environmental factors^[2].

This review focuses on Danti Moola (*Baliospermum montanum* Muell Arg.), an essential but pharmacologically sensitive root in Ayurvedic medicine. Categorized in the Charaka Samhita under Moolini Dravyas (root-dominant purgatives) and the Bhedaniya Mahakashaya (accumulation-breaking group)^[3], Danti serves as a classic example of Teekshna Virechana (drastic purgative) therapy. It operates through intense, fast-acting properties: Vyavayi (diffusing throughout the body prior to digestion) and Vikashi (loosening structural tissue bonds and depleting Ojas)^[4].

Because Danti relies on active diterpene molecules for its therapeutic actions, its margin of safety is narrow. A minor shift in environmental conditions can easily push its chemistry from a safe, controlled therapeutic agent into a severe mucosal irritant capable of inducing intense gastrointestinal inflammation and dehydration.

This paper bridges ancient classical text with contemporary molecular biology. It synthesizes the principles of Charakokta Desha Bheda with modern Eco pharmacognosy the science analysing how specific macro-climatic, hydrological, and soil parameters dictate the internal anatomy and secondary chemical defences of medicinal plants.

2. Classical Mapping of Desha Bheda & Textual Foundations

Ayurvedic climatology and geography analyse landmasses using an ecological framework. Land is categorized based on its water profile, wind patterns, solar radiation, native plant species, animal populations, and the corresponding Dosha dynamics of the region.

Charakokta Desha Classification

Charakokta Desha Classification		
▼	▼	▼
[Jangala Desha]	[Sadharana Desha]	[Anupa Desha]
Arid/Xeric Zone	Temperate/Balanced Zone	Wetland/Hydromorphic Zone
Agni / Vayu Dominant	Equal Mahabhutas	Jala / Prithvi Dominant
Vata-Pitta Biosphere	Sama-Dosha Baseline	Kapha-Vata Biosphere

2.1 Jangala Desha (The Arid/Xeric Eco-zone)

Acharya Charaka defines Jangala Desha through specific geographic and atmospheric markers:

जङ्गलं तु अल्पोदकद्रुमं मारुतभूयिष्ठं प्रकाशबहुलम् अकिञ्चित्कुल्यम्... (चरक संहिता, कल्प स्थान १/८)

The Jangala territory is distinguished by a scarcity of water bodies and trees, an abundance of dry winds, wide open skies with high solar exposure, and minimal river tributaries...

Key attributes found across classical commentaries include: Aero-Hydrology: Deep groundwater tables, minimal rainfall, and the presence of Sthira-shushka-pavana (persistent, hot, moisture-depleting winds)^[5]..

Classical Indicator Flora: Dominance of drought-resistant, deeply rooted, or thorny vegetation: Khadira (*Acacia catechu*), Asana (*Pterocarpus marsupium*), Badari (*Ziziphus mauritiana*), Sami (*Prosopis cineraria*), and Sallaki (*Boswellia serrata*).

Systemic Bio-Climate: Governed elementally by Agni and Vayu Mahabhutas, generating an environment dominated by Vata-Pitta.

2.2 Anupa Desha (The Hydromorphic/Wetland Eco-zone)

In contrast, Anupa Desha represents a high-moisture, low-evaporation water-logged ecosystem:

आनूपं तु बहुदकद्रुमं सरित्समुद्रपर्यन्तं शिशिरपवनबहुलं... (चरक संहिता, कल्प स्थान १/८)

The Anupa territory contains an abundance of water and dense forests, borders major rivers or oceans, and is characterized by cool, damp, humid winds.

Key classical attributes include: Aero-Hydrology: Saturated soils, water-logged conditions, and Shishira-pavana-bahula (cold, dense, humid air masses that minimize transpiration stress).

Classical Indicator Flora: Dense, fast-growing trees that thrive near water: Hintala (*Phoenix paludos*), Tamala (*Crataeva nurvala*), Narikela (*Cocos nucifera*), Kadali (*Musa paradisiaca*), and Vatasā (*Salix caprea*).

Systemic Bio-Climate Governed elementally by Jala and Prithvi Mahabhutas, maintaining an environment dominated by Kapha-Vata.

2.3 Sadharana Desha (The Intermediate/Temperate Eco-zone)

Sadharana Desha represents the transition zone where the extremes of both Jangala and Anupa are balanced:

उभयदेशलक्षणं संमिश्रं साधारणं मन्यते..... (चरक संहिता, कल्प स्थान १/८)

The land that blends the physical characteristics of both zones without falling into extremes is recognized as Sadharana.

It functions as a balanced baseline with moderate rainfall, stable seasons, and an even distribution of all five Mahabhutas, creating a stable Sama-Dosha environment.

3. Pharmacological & Botanical Profile of Danti

3.1 Classical Critical References

In Charaka Kalpa Sthana, Chapter 12 (Danti-Dravanti Kalpam), Acharya Charaka focuses on the roots of Danti as the primary therapeutic part, noting its strong, deep-acting properties. Because raw Danti Moola contains irritating compounds that can cause burning sensations in the throat and stomach, classical texts mandate a specific purification process (Shodhana) before clinical use:

दन्तीमूलादि लेपयेत् पिप्पलीमधुसंयुतम्। कुशैर्वैष्टयित्वा स्विन्नं कुर्यात् मृदुकर्मणे॥ (च. सं. कल्पस्थान १२)

The root is coated with a paste of Pippali (Piper longum) and Madhu (honey), wrapped tightly in Kusha (Desmostachya bipinnata), and heated (Swedana). Modern analysis shows this ancient heat treatment helps break down or melt away volatile, toxic diterpene resins^[6].

3.2 Traditional Rasa Panchaka Profile

The intense, purgative nature of Danti stems from its sharp, heating properties: Rasa: Katu (Pungent) Stimulates local secretomotor responses in the gut wall. Guna: Guru (Heavy), Tikshna (Sharp), Ruksha (Dry) Long transit time, high tissue penetration, induces mucosal secretions. Veerya: Ushna (Hot) Increases metabolic conversion and dilates channels. Vipaka: Katu (Post- Digestive Pungent) Drives catabolism and systemic elimination. Vyavayi & Vikashi: Severe Tissue Diffusion Rapidly crosses cellular barriers; disrupts cellular bonds to loosen Doshas. Karma: Teekshna Virechana (Drastic Purgative) | Induces active fluid accumulation and fast intestinal purging.

3.3 Modern Botanical Identity

Danti is botanically identified as *Baliospermum Montanum Muell.Arg*, belonging to the *Euphorbiaceae* family. It is a leafy, monoecious undershrub with distinctive, variable leaves and small, green-yellow flowers. It grows naturally across moist deciduous forests from Kashmir down to the Western Ghats of India.

Like many members of the *Euphorbiaceae* family, its roots contain specialized structures called laticifers. These structures produce a thick latex rich in nitrogenous alkaloids, resins, and specialized diterpene compounds called Phorbol esters (such as 12-deoxyphorbol and its derivatives), which act as strong mucosal irritants^[7].

4. The Eco pharmacognostical Synthesis: Cellular & Metabolic Plasticity

Plants cannot move to escape environmental stress. Instead, they rely on metabolic and structural adjustments to survive pressures like drought, water-logging, or high solar radiation.

4.1 Morphological & Anatomical Adaptations (Pharmacognosy)

Anatomical Parameter affects on Physiological Mechanism

A= Jangala Desha (Arid/High Stress)

B= Anupa Desha (Wetland/Low Stress)

C= Sadharana Desha (Temperate Baseline)

Outer Cork (Phellem) of A-heavily thickened, multi-layered, highly suberized. /B-thin-walled, minimal suberization layers. / C- balanced; Moderate cell layers prevent moisture loss under high evaporative pull^[8].

Cortical Parenchyma of A- compactly arranged, high density of sclereids (stone cells). / B- highly dilated, thin-walled, with distinct parenchyma spaces. / C-standard parenchymatous architecture; Aerenchyma aids gas transport in water-logged, low-oxygen soil^[9].

Xylem Vessel Architecture of A- narrow lumens, heavily lignified walls, tightly packed.

/ B-Wide lumens, thin vascular walls, porous arrangement. / C- Moderately sized lumens with standard distribution; Narrow lumens prevent air bubbles (cavitation) during drought^[10].

Cellular Ergastic Crystals of A-Dense clusters of prismatic calcium oxalate crystals. / B- Rare or completely absent. / C-Sparse, isolated crystal arrangements; Excess calcium is dumped as crystals during moisture stress^[11].

Medullary Rays of A- Multiseriate, compact, packed with small starch granules. B-Uniseriate, wide, elongated with loose starch storage. C- balanced radial transport cells; Compact rays maintain structural integrity under low water pressure^[12].

4.2 Phytochemical Fingerprint Variations (Phytochemistry)

The secondary metabolites in a plant function primarily as chemical defence networks against environmental pressures, pests, and microbial infections.

Agro-Climatic Microclimate (Desha) of

Jangala Environment: High Heat / Water Deficit • Constant Water Saturation

and Anupa Environment: Oxidative / Thermal Stress • Minimal Environmental Stress

Up-regulated Defence [Primary Growth Focus] of Jangala: High Shikimate / Terpenoid Pathway, High Phenols & Flavonoids and Anupa: High Carbohydrate / Biomass, Low Phytochemical Synthesis

Phytochemical Density of Jangala: Concentrated Phorbol Esters and Narrower Therapeutic Window and Anupa: Diluted Phorbol Esters and Risk of Therapeutic Failure

A. Up-Regulation Pathways in Jangala Desha

When *Baliospermum montanum* Muell Arg. grows in the arid conditions of Jangala Desha, it is exposed to high ultraviolet radiation and water deficits, which generate reactive oxygen species (ROS) within its cells. To survive, the plant activates its protective pathways:

1.The Shikimate & Phenylpropanoid Pathway: Up-regulated to produce high concentrations of polyphenols, condensed tannins, and flavonoids^[13]. These compounds serve as powerful internal antioxidants, protecting cellular membranes from drying out and experiencing thermal breakdown.

2.The Mevalonate & Isoprenoid Pathway: Heavily activated under drought stress. This pathway controls the synthesis of complex diterpene compounds, causing a sharp increase in phorbol esters (specifically montanin, baliospermin, and 12-deoxyphorbol-13-palmitate)^[14]. These compounds are highly bitter and cytotoxic, working to deter herbivores

in scarce, resource-limited arid zones. As a result, the root profile becomes highly concentrated and intensely potent.

B. Dilution and Allocation Shifts in Anupa Desha

Conversely, the wet, nutrient-dense conditions of Anupa Desha place very little environmental stress on the plant. According to the Carbon-Nutrient Balance Hypothesis (CNBH), when a plant has access to abundant water and nitrogen, it prioritizes primary metabolism over secondary defence networks^[15].

Primary Biomass Focus: Energy is directed toward expanding physical size, enlarging leaves, and accumulating carbohydrates, primary proteins, and free starches.

The Dilution Effect: Because defensive pathways are not triggered, the production of active alkaloids and diterpenes drops significantly. Chromatographic fingerprinting (HPTLC) of roots harvested from water-logged zones reveals much smaller peaks for therapeutic phorbol esters, indicating a diluted, less active chemical profile^[16].

5. Discussion

Connecting Panchamahabhuta with Molecular Biology

Integrating classical Ayurvedic theory with contemporary plant physiology clarifies the functional science behind habitat-based drug selection:

5.1 The Mahabhuta Dynamics

The classical assignment of Jala and Prithvi Mahabhutas to Anupa Desha aligns directly with hydromorphic soil profiles characterized by high water tables and low oxygen availability. In terms of pharmacological properties (Guna), this environment introduces Guru (heaviness), Manda (sluggishness), and Sheeta (coldness). When Danti grows under these conditions, its aggressive, sharp (Tikshna) and hot (Ushna) properties are naturally buffered. The lower concentration of irritant phorbol esters means the root produces a gentler secretomotor effect in the gut, making its purgative action (Virechana Vega) milder and safer for sensitive patients.

In contrast, the Agni and Vayu dominance of Jangala Desha introduces Ruksha (dryness), Laghu (lightness) and Tikshna factors. This directly mirrors the high ambient temperatures, low humidity, and intense solar radiation of arid zones. The plant responds to this environmental stress by concentrating its defensive chemical profile. Sourcing Danti Moola

from an arid Jangala zone yields a drug with high concentrations of phorbol resins. If this root is manufactured without strict adherence to classical purification (Shodhana) protocols, it can cause severe gastrointestinal irritation, excessive purging (Atiyoga), bloody stools, and intense mucosal inflammation (Daha).

5.2 Clinical Implications for Modern Pharmacopeial Standards

This analysis highlights why standardizing raw herbal drugs based entirely on botanical identification can compromise clinical safety and efficacy:

1. The Risk of Toxicity (Arid Sourcing): Raw materials gathered from Jangala regions contain a concentrated chemical profile. Processing them using standard manufacturing techniques can yield a product that induces hyper-purgation and adverse inflammatory reactions in clinical practice.

2. The Risk of Therapeutic Failure (Wetland Sourcing): Materials gathered from Anupa environments feature a diluted chemical profile. This can lead to a weak or absent Bhedana (accumulation-breaking) action, resulting in therapeutic failure when treating deep-seated metabolic conditions.

Therefore, ancient Desha Pariksha is not an abstract cultural classification; it is an early form of ecological and chemical standardization that should be integrated into modern quality control methods for Ayurvedic pharmaceuticals.

6. Conclusion & Future Research Directions

This review demonstrates that the classical Charakokta framework of Desha Bheda provides a clear, reliable system for identifying natural variations in medicinal plants. The contrasting environments of Anupa, Jangala, and Sadharana Deshas create specific ecological pressures that directly alter the cellular structure and secondary chemical defences of Danti Moola.

To validate these traditional concepts for modern integration, future experimental studies should focus on:

Conducting comparative HPTLC and LC-MS/MS profiling to quantify specific phorbol ester content across certified eco-types.

Evaluating structural differences in tissue layers using advanced powder microscopy and histochemical staining.

Assessing how different Desha sources impact the cell-level toxicity and therapeutic behaviour of the drug before and after Shodhana processing.

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