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Bridging Ayurveda and Modern Pharmacology: A Review of *Gurvadi Guna* Correlations with Physicochemical and Molecular Parameters

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ABSTRACT

Background: *Gurvadi Guna*, the twenty fundamental qualitative attributes described in Ayurvedic pharmacology, serve as a traditional framework for predicting the therapeutic behaviour of substances. Despite their longstanding use, systematic scientific correlations between these classical properties and contemporary physicochemical or molecular parameters remain insufficiently explored.

Aim: To systematically review and establish correlations between Ayurvedic *Gurvadi Guna* and modern physicochemical, molecular, and pharmaceutical properties, thereby facilitating evidence-based integration of traditional pharmacological concepts with modern science.

Methods: A comprehensive literature search was conducted across PubMed/PMC, ScienceDirect, and leading Ayurvedic journals using terms such as *"Gurvadi Guna,"* "Ayurvedic pharmacology," "molecular correlation," and "physicochemical properties." Classical references were examined from Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya.

Results: Multiple consistent correlations emerged between Ayurvedic attributes and measurable scientific parameters. *Guru* (heavy) and *Laghu* (light) demonstrated parallels with oral bioavailability and glycemic indices. *Sheeta* (cold) and *Ushna* (hot) aligned with thermodynamic behaviour influencing enzyme kinetics and metabolic activity. *Snigdha* (unctuous) and *Ruksha* (dry) showed associations with lipophilicity, membrane permeability, and biochemical markers, with *Snigdha* substances enhancing membrane stability and glutathione, while *Ruksha* substances exhibited anti-adipocytic effects. Additional correlations included diffusion coefficients for *Sthira* (stable) versus *Sara* (mobile), particle-size and permeability for *Sukshma* (minute) versus *Sthula* (gross), and adhesive characteristics for *Vishada* (conspicuous) versus *Picchila* (slimy).

Conclusion: This review highlights robust preliminary correlations between *Gurvadi Guna* and modern physicochemical parameters, providing a scientific basis for their contemporary interpretation while identifying areas requiring further empirical validation.

Keywords: *Gurvadi Guna*, molecular correlation, physicochemical properties, traditional medicine, pharmacology

INTRODUCTION

Ayurveda represents a comprehensive traditional medical system encompassing sophisticated pharmacological frameworks based on observable properties of medicinal substances. Central to this system are the *Gurvadi Guna,* twenty fundamental qualities that determine therapeutic actions and physiological effects of drugs and dietery substances. These properties serve as predictive tools for understanding substance interactions with human physiology, particularly their influence on the three bioenergetic principles: *Vata*, *Pitta* and *Kapha*.[1]

The traditional Ayurvedic pharmacological framework emphasizes that *Guna* represents inherent characteristics of substances that remain constant regardless of external conditions. These properties are organized as ten pairs of opposite qualities: *Guru-Laghu* (heavy-light), *Sheeta-Ushna* (cold-hot), *Snigdha- Ruksha* (unctuous-dry), *Manda-Tikshna* (mild-sharp), *Sthira-Sara* (stable-mobile), *Mridu-Kathina* (soft-hard), *Sandra-Drava* (dense-fluid), *Sukshma-Sthula* (minute-gross), *Shlakshna-Khara* (smooth-rough), and *Vishada-Picchila* (conspicous-slimy).

Despite extensive traditional use spanning millennia, systematic correlations between *Gurvadi Guna* and quantifiable physicochemical parameters remain inadequately explored in scientific literature. This review aims to critically examine available evidence for correlations between classical Ayurvedic *Gurvadi Guna* and modern molecular and physicochemical parameters, assess the strength of existing evidence-based integration of traditional pharmacological concepts with modern pharmaceutical science, identify research gaps, and propose directions for empirical validation studies.

MATERIALS & METHODS

This review article is based on classical Ayurvedic texts Textual like Charaka Samhita, Sushruta Samhita and Ashtanga Hridaya. Databases such as PubMed, AYUSH Research Portal, and Scopus were searched using keywords like *Gurvadi Guna*," "Ayurvedic pharmacology," "molecular correlation," "physicochemical properties" and "pharmaceutical properties".

Inclusion Criteria: The inclusion criteria comprised peer-reviewed studies published in indexed journals, classical Ayurvedic texts supported by established translations, studies that examined the physicochemical properties of medicinal substances, and research that explored pharmaceutical correlations with traditional Ayurvedic principles.

Exclusion Criteria: The exclusion criteria ruled out non–peer-reviewed publications, studies lacking a clear and reproducible methodology, and articles that did not provide adequate or appropriate citations.

RESULT

Guru (Heavy) - *Laghu* (Light) *Guna* Pair

Guru Guna produces heaviness, slow digestion, nourishment, and stability in the body, while *Laghu Guna* generates lightness, rapid digestion, and metabolic stimulation. *Guru* properties predominate in substances with *Prithvi* (earth) and *Jala* (water) elements, characterized by density, solidity and grounding effects. *Laghu* properties correlate with *Agni* (fire), *Vayu* (air) and *Akasha* (space) elements manifesting as reduced density and increased metabolic activity.[2]

Recent pharmaceutical research demonstrates significant correlations between *Guru-Laghu* properties and molecular weight parameters governing oral bioavailability. Substances exhibiting *Guru Guna* characteristics correlate with high molecular weight compounds (exceeding 500 Daltons), aligning with Lipinski's Rule of Five for drug-likeness. From a modern pharmacological perspective, *Guru Guna*

can be correlated with density and molecular weight, where substances with heavier molecular weights demonstrate slower rates of absorption and metabolism compared to lighter compounds.[3]

Physicochemical analysis of traditionally classified *Guru* substances like *Shatavari* (*Asparagus racemosus* Willd) reveals molecular weights exceeding the 500 Da threshold, with corresponding low oral bioavailability and prolonged digestive transit times. The molecular characteristics include high density (exceeding 1.0 g/cm³), increased viscosity, and reduced solubility coefficients, validating traditional descriptions of difficulty in digestion and slow metabolic processing.[4]

Conversely, *Laghu Guna* corresponds to compounds with molecular weights below 500 Da, exhibiting rapid absorption and high oral bioavailability. Research validates that lighter molecules with fewer rotatable bonds (below 10) and reduced polar surface area (below 140 Ų) demonstrate enhanced membrane permeability and faster pharmacokinetic profiles. This aligns precisely with Ayurvedic principles describing *Laghu* substances as kindling *Agni* (digestive fire) and promoting rapid metabolic processes.[3]

Comprehensive nutritional studies demonstrate remarkable correlation between *Guru-Laghu* properties and glycemic indices of foods. Physicochemical analysis confirms that *Guru* substances like *Shatavari* exhibit significantly lower glycemic indices (15-25), indicating prolonged digestion and sustained nutrient release, while *Laghu* substances like *Kushmand* (*Benincasa hispida* (Thunb.) Cogn.) demonstrate higher glycemic indices (70-75), reflecting rapid carbohydrate absorption and quick metabolic processing.[4]

***Sheeta* (Cold) – *Ushna* (Hot) *Guna* Pair**

Sheeta Guna as producing cooling sensations, reducing metabolic activity and causing contraction while *Ushna Guna* generates heat, increases metabolic processes and promote expansion. *Sheeta* properties predominate in substances with *Vayu* and *Jala* elements, whereas *Ushna* correlates with *Agni* dominance.[2]

Sheeta Guna operates through thermodynamic mechanisms involving endothermic reactions and reduced molecular kinetic energy. Clinical investigations confirm that *Sheeta* acts through cooling anti-inflammatory pathways, being central to *Kapha* and *Vata* pathophysiology. Thermodynamic parameters include negative enthalpy changes ($\Delta H < 0$) and reduced enzyme activity coefficients, correlating with physiological effects including vasoconstriction, anti-inflammatory responses and metabolic suppression. Conversely, *Ushna Guna* demonstrates exothermic properties with positive enthalpy changes ($\Delta H > 0$) and increased molecular kinetic energy. Research confirms correlation with metabolic stimulation and increased enzymatic activity rates, manifesting as vasodilation, heightened metabolic rates, and enhanced enzyme activity underlying fever and pro-inflammatory states. Contemporary applications include cryotherapy protocols utilizing *Sheeta* properties for inflammation management and thermotherapy employing *Ushna* properties for metabolic stimulation. Modern research validates these correlations through enzyme kinetics studies demonstrating temperature-dependent reaction rates and thermodynamic analysis of metabolic processes.[5]

***Snigdha* (Unctuous) - *Ruksha* (Dry) *Guna* Pair**

Snigdha Guna produces moisture, unction, oozing, softness and moistening with *Santarpana Karma*. *Ruksha Guna* reduces unctuousness and produces roughness and non-sliminess with *Apatarpana Karma*.[6] *Snigdha* is dominant in *Jala* elements, while *Ruksha* is associated with

Vayu elements.[2] Comprehensive biochemical investigations demonstrate that *Snigdha* substances like ghee (clarified butter) enhance glutathione (GSH) levels and cell membrane integrity, supporting their traditional role in oxidative stress protection. Cell culture studies using 3T3-L1 adipocyte cell lines reveal that *Snigdha Guna* substances promote adipocytic activity, demonstrating enhanced membrane permeability and protoplasmic viscosity maintenance. Molecular characteristics of *Snigdha* substances include high lipid content, viscosity exceeding 10 centipoise (cP), and hydrophobic properties crucial for skin barrier repair and transdermal drug delivery applications. These findings validate traditional descriptions of *Snigdha* properties promoting cellular lubrication and tissue nourishment through membrane-mediated mechanisms.[7]

Ruksha Guna substances like *Arjuna* (*Terminalia arjuna* (Roxb.)W. & A) bark extracts demonstrate hydrophilic properties, low viscosity (below 1 cP), and desiccant characteristics. Cellular studies show that *Ruksha* substances exhibit anti-adipocytic effects and superior erythrocyte antioxidant protection compared to *Snigdha* substances, validating their traditional applications in obesity management and metabolic regulation. Water activity coefficients below 0.6 correlate with astringent pharmacological actions characteristic of *Ruksha* properties.[7] Modern applications include development of lipid-based drug delivery systems utilizing *Snigdha* properties for enhanced bioavailability and dermatological formulations for skin barrier restoration. *Ruksha* properties find applications in desiccant formulations and astringent preparations for wound healing and antimicrobial preservation.

Manda (Mild) - *Tikshna* (Sharp) *Guna* Pair

Manda Guna causes sluggishness, delays metabolic and digestive functions, and promotes a calm state, while *Tikshna Guna* induces rapidity, sharpens digestion, and stimulates intense physiological actions. *Manda* is linked to *Jala* and *Prithvi* elements, while *Tikshna* is correlated with *Agni* and *Vayu* elements.[2]

Contemporary molecular dynamics research on amorphous solid dispersions (ASD) reveals that drug stability is governed by the interplay of two competing factors: thermodynamic stabilization through favorable mixing energies and hydrogen bonding, and kinetic transformation through molecular mobility and diffusion rates. This dual-factor mechanism directly parallels the classical Ayurvedic concepts of *Manda* and *Teekshna* gunas opposing qualities that determine the action, duration, and transformation of therapeutic substances. *Manda Guna* (*Pritwi and Jala*) encodes the principle of thermodynamic stabilization: it slows transformation, prolongs duration, and creates resistance to change, functioning analogously to how strong drug-polymer interactions through hydrogen bonding reduce the free energy difference between amorphous and crystalline phases, thereby reducing the thermodynamic driving force for crystallization and prolonging stable amorphous residence. Conversely, *Teekshna Guna* (*Agni* and *Vayu*) encodes the principle of kinetic transformation: it accelerates action, penetrates barriers, and facilitates structural reorganization, mirroring how high molecular mobility enables drug molecules to diffuse through polymer matrices toward crystalline nucleation sites, overriding thermodynamic barriers through kinetic intensity.

Flufenamic acid exhibits *Manda*-dominant behavior, with strong hydrogen bonding and negative mixing energies creating thermodynamic stability that resists crystallization regardless of modest molecular mobility a manifestation of stabilizing forces overriding transformative ones. Conversely, phenacetin exhibits *Teekshna*-dominant behavior, with high molecular mobility driving rapid crystallization despite moderate thermodynamic favorability, demonstrating how kinetic intensity can overcome

protective barriers. This framework suggests that optimal pharmaceutical formulation parallels the Ayurvedic principle that health and stability emerge from balancing opposing qualities: formulations must simultaneously maximize thermodynamic favorability (*Manda*) while minimizing molecular mobility (constraining *Teekshna* manifestation), revealing that ancient categorization systems identified and encoded fundamental principles of material behavior now observable at the molecular scale through modern computational chemistry. The pharmaceutical finding that either factor can be rate-limiting depending on the drug's physicochemical properties demonstrates that formulation success requires understanding the specific interplay of *Manda*-like thermodynamic stabilization and *Teekshna*-like kinetic reactivity for each drug-polymer combination.[8]

Sthira (Stable) - *Sara* (Mobile) *Guna* Pair

Sthira Guna confers steadiness, strengthens tissues, and restricts movement, while *Sara Guna* encourages fluidity, flexibility, and dynamic movement. *Sthira* is found in substances dominated by *Prithvi* elements, whereas *Sara* is present in those with *Jala* predominance.[2]

Sthira Guna correlates with crystalline molecular structures exhibiting low diffusion coefficients and sustained pharmacological activity. Research on crystal growth mechanisms and molecular stability confirms pharmaceutical utility in depot formulations and long-acting therapeutics. Crystalline (solid) structures ensure prolonged action and molecular stability in sustained-release systems through reduced molecular mobility.[9] Sara Guna demonstrates correlation with amorphous structures having high diffusion coefficients, enabling rapid systemic distribution and quick pharmacological onset. Studies on amorphous solid dispersions show improved solubility and bioavailability for poorly soluble drugs, validating traditional concepts of mobility facilitating rapid distribution and therapeutic effect.[8]

The X-ray diffraction (XRD) findings of *Mukta Bhasma* and *Mukta Pishti* reveal distinct microstructural characteristics that align with the classical Ayurvedic concepts of *Sthira* and *Sara gunas*. *Mukta Bhasma*, prepared through high-temperature incineration, demonstrates highly crystalline peaks of calcium carbonate and calcium oxide, indicating a stable, rigid lattice structure. This enhanced crystallinity, coupled with a smaller particle size (100–250 nm) and higher zeta potential (−28 mV), reflects the *Sthira Guna* - immobility, firmness, and resistance to change making it suitable for chronic systemic disorders and tissue-stabilizing actions as described in Ayurvedic pharmacology. In contrast, *Mukta Pishti*, prepared by cold levigating, shows semi-crystalline XRD patterns with broader peaks and organic traces, indicating a more disordered, labile structure. Its larger particle size (500–900 nm) and lower zeta potential (−18 mV) suggest greater solubility and dispersibility, correlating with *Sara Guna* - mobility and fluidity, which supports its use in acute *Pitta*-dominant conditions requiring swift action and metabolic movement.[10]

Mridu (Soft) - *Kathina* (Hard) *Guna* Pair

Mridu (softness) and *Kathina* (hardness) as opposing *Gurvadi Guna's* that determine the tactile and functional quality of *Dhatus* and *Dravya*. *Mridu Guna* produces softness, smoothness, and gentleness, while *Kathina Guna* causes roughness, dryness, and friction. *Mridu* is associated with *Jala* and *Akasha*, while *Kathina* is linked to *Prithvi* elements. In modern biomechanical terms these properties map naturally to measurable tissue mechanical behaviour *Mridu* corresponds to low stiffness/high compliance and viscoelasticity, whereas *Kathina* corresponds to high stiffness/low compliance and reduced deformability.

Contemporary studies implicate extracellular matrix composition (collagen content and cross-linking), tissue hydration, and cellular-level changes as primary drivers of measured stiffness. Increased collagen deposition and enzymatic or non-enzymatic cross-linking create a stiffer, *Kathina*-like microenvironment measurable by elastography and associated with fibrosis, aging and impaired function. Conversely, greater bound water, lower collagen ordering, and lipid-rich (non-fibrotic) adipose are associated with increased compliance (*Mridu*). These mechanistic links explain why modalities traditionally described as *Mridu*-promoting in Ayurveda (e.g., *Snigdha* treatments, *Abhyanga*, *Mridu Sveda*) may produce objectively measurable reductions in tissue stiffness, while chronic pathological processes shift tissues toward *Kathina*. Translating these concepts into quantitative metrics enabling rigorous clinical trials that bridge Ayurvedic theory with modern tissue biomechanics.[11]

Sandra (Dense) -*Drava* (Fluid) *Guna* Pair

Sandra (dense) and *Drava* (liquid, fluid) as a paired opposition in the *Gurvadi Gunas*, where *Sandra* denotes compactness, stability and reduced fluid mobility, and *Drava* denotes flow, diffusibility and greater fluid/matrix mobility.[12] *Sandra* is prevalent in *Prithvi* elements , while *Drava* is dominant in *Jala* elements.[2] Biomechanical research demonstrates that soft tissues behave as visco-poroelastic media, in which the interplay of solid fibre (collagen/elastin) matrix and interstitial fluid determines deformation, stress–relaxation and mechanical response. When tissues shift towards fibrosis, increased cross-linking and decreased hydration, stiffness rises and the *"Sandra"* characteristic predominates; conversely, when hydration is high, matrix is less dense and fluid mobility is greater, the *Drava* characteristic predominates. Clinically, recognizing these shifts supports interventions: excessive *Sandra* (rigid, stagnated tissues) may benefit from therapies enhancing fluidity (increasing *Drava*) excessive *Drava* (weak, overly fluid tissues) may require stabilizing and densifying (enhancing *Sandra*) treatments. Embedding these *Guna*-concepts alongside quantitative tissue assessments enables rigorous bridging of Ayurvedic theory and modern biomechanics in a research framework.[13]

Sukshma (Minute) -*Sthoola* (Gross) *Guna* Pair

Sukshma Gunas, characterized by minuteness, penetrability and pervasiveness reflects the capacity of a substance to diffuse through fine biological channels and act at deeper levels of tissues (*Srotas*). In contrast, *Sthula Guna* denote grossness, density and limited diffusion producing stability and localized activity. *Sthulatva* is found in *Prithvi* , while *Sukshmatva* is present in *Agni*, *Vayu* and *Akasha* elements.[2] These qualitative attributes, described in classical texts represent a spectrum of structural fineness and functional reach that parallels contemporary physical descriptors such as particle size , surface area and permeability.

An Emerging Discipline offer compelling empirical validation for the Ayurvedic concepts of *Sukshma* and *Sthula Gunas* by using nanotoxicology. The study revealed that ultrafine or nano sized particles display markedly enhanced biological reactivity and the ability to traverse epithelial and endothelial barriers, reaching distant organs and cellular compartments. This behaviour closely parallels the property of *Sukshma Guna*, denoting fineness and penetrability that permit deep and pervasive action within subtle pathways called *Srotases*. In contrast, larger or agglomerated particles remain localized and exhibit restricted systemic activity, reflecting the stabilizing and confined nature of *Sthula Guna*. Thus, contemporary nanoscience substantiates the Ayurvedic assertion that subtle entities exert profound, wide-ranging effects, whereas gross forms act locally with limited

diffusion bridging traditional qualitative ontology and modern nanoscale biophysics.[14]

Shlakshna (Smooth) -*Khara* (Rough) *Guna* Pair

Slakshna Guna imparts smoothness, lubrication, and aids in healing by promoting tissue repair and enhancing the smooth movement of bodily contents, while *Khara Guna* produces roughness, causes tissue scraping, and may lead to depletion or damage of tissues due to its abrasive nature. *Slakshna* is associated with the healing and nourishing qualities found in substances dominated by *Akasha /Agni* elements, whereas *Khara* is linked to *Vayu* and *Agni* elements, promoting catabolism and roughness.[2]

Shlakshna Guna demonstrates correlation with low friction coefficients and smooth surface topology, facilitating easy administration and promoting healing properties. Development of standardized assessment criteria for *Shlakshna Guna* confirms its role in promoting patient comfort, reducing mucosal irritation, and enhancing compliance in pharmaceutical preparations.[15] *Khara Guna* exhibits high friction coefficients and irregular surface topology, correlating with scraping actions and enhanced disintegration properties in pharmaceutical formulations. Rough particles aid mechanical cleansing in topical applications and improve tablet disintegration in oral pharmaceutical preparations. Due to the lack of sufficient data, the validation of *Shlakshna Guna* remains challenging, which opens opportunities for further research and exploration in this area.

Vishada (Conspicuous) - *Picchila* (Slimy) *Guna* Pair

Vishada Guna imparts clarity, cleanses the body by removing excess moisture and impurities, and promotes detoxification and healing, while *Picchila Guna* causes stickiness, adhesion, and retention, leading to increased bulk and smoothness in tissues and bodily channels. *Vishada* is associated with *Vayu*, *Akasha*, *Prithvi* and *Agni* elements, supporting detoxification and reduction of *Kapha*, whereas *Picchila* is linked to *Prithvi* elements, promoting lubrication and stability.[2]

The principles underlying mucoadhesive drug delivery systems (MDDS) embody a modern expression of two opposing Ayurvedic *Guna's*, *Picchila* and *Vishada*. The adhesive polymers used in MDDS interact with mucin to form a cohesive, viscous layer that prolongs drug residence at the mucosal surface. Such behaviour epitomizes *Picchila Guna*, whose intrinsic qualities of stickiness, cohesion, and resistance to displacement confer stability and sustained contact. In contrast, formulations that minimize adhesion, reduce viscosity, and permit rapid drug diffusion across mucosa manifest *Vishada Guna*, representing clarity, smooth flow, and unobstructed movement.[16]

By translating these classical attributes into measurable physicochemical parameters adhesive strength, viscosity index, and diffusion rate Ayurvedic *Guna* theory attains a tangible form within modern scientific culture. A formulation dominated by *Picchila Guna* demonstrates prolonged bio-adhesion and controlled release, while one expressing *Vishada Guna* exhibits quick dispersion and faster systemic uptake. This alignment illustrates how ancient qualitative descriptors accurately anticipate the functional dynamics of adhesion and flow in drug delivery, reaffirming Ayurveda's timeless relevance to biomaterial design and pharmacokinetics.

DISCUSSION

The present review establishes a structured scientific framework correlating the Ayurvedic concept of *Gurvadi Guna* with modern physicochemical, molecular, and biopharmaceutical parameters, implying potential alignment between Ayurvedic concepts and measurable scientific

parameters, although further empirical validation is required.

The correlations demonstrated that *Guru-Laghu Guna's* closely parallel variations in molecular weight and bioavailability, consistent with pharmacokinetic laws such as Lipinski's Rule of Five. Similarly, *Sheeta-Ushna Guna's* exhibits clear thermodynamic correspondence with endothermic and exothermic reaction profiles, validating Ayurvedic temperature-based classifications through measurable enthalpy changes and enzyme kinetics. Beyond thermodynamic behaviour, biochemical polarity offers another domain for meaningful *Guna* correlations, *Snigdha-Ruksha Guna* pair reflects the biochemical polarity between lipidic and hydrophilic properties, aligning with membrane permeability, antioxidant protection, and moisture retention indices. Furthermore, the *Manda-Tikshna Guna's* was shown to correlate with the dynamic balance between thermodynamic stabilization and kinetic reactivity in amorphous solid dispersions, revealing that Ayurveda's understanding of rate and intensity of action parallels molecular mobility and energy differentials studied in modern pharmaceutics. Structural and microcrystalline analyses further extend these correlations. The XRD findings of *Mukta Bhasma* and *Mukta Pishti* demonstrate that their distinct microstructural characteristics high crystallinity and smaller particle size in *Mukta Bhasma* versus semi-crystalline structure and larger particles in *Mukta Pishti* correlate with the classical Ayurvedic concepts of *Sthira* (immobility and stability) and *Sara* (mobility and fluidity), respectively, supporting their differential therapeutic applications. Likewise, collagen cross-linking and extracellular matrix hydration quantitatively validate *Mridu-Kathina* differences in compliance and rigidity. The *Sandra-Drava* pair aligns with poro-viscoelastic modeling of tissues, demonstrating that compactness and fluidity coexist as complementary determinants of biological mechanics. Moving from bulk material behaviour to nanoscale interactions provides even deeper clarity. At the nanoscale, the *Sukshma-Sthula Guna* correlation is substantiated by nanotoxicological studies, where nanoparticulate penetration and high surface reactivity typify *Sukshma*, while bulk material confinement reflects *Sthula*, affirming Ayurveda's early recognition of scale-dependent bioactivity. Surface morphology and interfacial behaviour form another domain of correlation. *Slakshna-Khara Guna's* are expressed in the surface dynamics of biological and synthetic surfaces, where smooth, low-friction surfaces enhance tissue compatibility and comfort (*Slakshna*), whereas rough, high-friction textures promote abrasion, disintegration, and scraping actions (*Khara*). Extending from surface interactions to adhesive dynamics offers further translational relevance. Finally, the *Vishada-Picchila Guna* pair finds clear modern correspondence in the design of mucoadhesive drug delivery systems (MDDS). Polymers that adhere to mucosal surfaces and form cohesive viscous films typify *Picchila Guna*, conferring sustained contact and controlled release, while formulations exhibiting rapid diffusion and minimal adhesion exemplify *Vishada Guna*, enabling unobstructed flow and rapid systemic uptake. This explicit linkage between ancient pharmacodynamic descriptors and measurable adhesive or rheological parameters demonstrates the translational capacity of Ayurvedic ontology when analysed through modern biophysical instrumentation.

Although the reviewed literature demonstrates promising correlations between *Gurvadi Guna's* and modern physicochemical properties, several methodological limitations restrict definitive conclusions. The studies included in this review varied widely in experimental design, analytical techniques, and reporting standards, making direct comparison difficult. Several *Guna* pairs, particularly those related to kinetic behaviour and scale-

dependent interactions, lack sufficient contemporary experimental data for robust mapping. Moreover, many correlations remain conceptual due to the absence of standardized quantitative indices to measure *Guna's*. These gaps highlight the need for systematic, controlled studies and uniform methodological frameworks to strengthen the scientific interpretation of traditional Ayurvedic constructs.

The integration of traditional knowledge systems with modern scientific methodology has emerged as a critical research priority, particularly for developing personalized medicine approaches. The Collaborative Medicine and Science (Co.M.S.) framework proposes bidirectional exploration between traditional systems and modern science, emphasizing the value of leveraging comprehensive systemic frameworks to contextualize contemporary pharmaceutical phenomena.[17]

CONCLUSION

The review highlights that Ayurvedic *Guna's* offer a structured qualitative framework that may correspond to measurable physicochemical and pharmacological properties. Current evidence indicates promising correlations, although methodological heterogeneity limits definitive conclusions. Several *Guna's* still lack robust experimental validation. Integrating modern analytical tools with classical interpretations can strengthen scientific understanding. Future research should focus on developing quantitative indices that translate Ayurvedic *Guna's* into measurable physicochemical parameters. Computational modelling, omics-based characterization, and controlled pharmacological experiments are required to validate these theoretical correlations. Standardized methodologies and reproducible experimental frameworks will help bridge textual descriptions with modern scientific evidence.

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