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Vedic Chemical Insights as Precursors to Modern Green and Sustainable Chemistry: An SDG-Aligned Perspective

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Abstract

This paper explores the chemical insights found in ancient Vedic texts and their relevance to contemporary green and sustainable chemistry. It examines the alchemical traditions described in Vedic literature, such as Rasaśāstra, which integrate material and spiritual aspects of transformation. The study investigates how ancient chemical processes align with modern principles of green chemistry, including waste reduction, use of renewable resources, and energy efficiency. By analyzing the parallels between Vedic practices and current sustainable approaches, the paper aims to illuminate the historical evolution of chemical thought and its impact on modern green chemistry. Additionally, it considers the potential benefits and challenges of integrating ancient alchemical wisdom with contemporary scientific research. This exploration seeks to foster a deeper appreciation of the interconnectedness between ancient knowledge and modern science, potentially inspiring innovative approaches to sustainability in chemistry. In this context, the study situates Vedic chemical practices within the framework of the United Nations Sustainable Development Goals, demonstrating relevance to SDG 3 (Good Health and Well-Being) through plant-based medicinal knowledge, SDG 6 (Clean Water and Sanitation) via traditional purification methods, and SDG 7 (Affordable and Clean Energy) through low-energy processes. The emphasis on resource efficiency, waste minimization, and ecological balance further aligns these practices with SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land), underscoring the contemporary sustainability relevance of ancient Vedic chemical wisdom.

Keywords: *Ancient chemical processes, green chemistry, green chemistry, Rasaśāstra, sustainable practices, Vedic alchemy*

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INTRODUCTION

The ancient Vedic texts of India, written thousands of years ago, contain a wealth of knowledge that has significantly influenced various fields, including philosophy, medicine, astronomy, and chemistry [1]. Among these, the alchemical traditions described in these texts offer profound insights into early chemical practices and philosophies [2]. Vedic literature, encompassing texts such as the Rigveda, Atharvaveda, and various Upanishads, is renowned for its rich philosophical and scientific content. These texts are not only spiritual and religious guides but also repositories of empirical knowledge and practical techniques [3, 4]. The Vedic approach to alchemy, known as Rasaśāstra, integrates both the material and the spiritual, aiming for the transformation of both

substances and the self [5]. This holistic perspective is strikingly relevant to today's green chemistry, which seeks to minimize environmental impact while promoting sustainability and human well-being [6, 7]. The Vedic texts describe numerous chemical processes, such as distillation, calcination, and extraction, which are foundational to modern chemistry. These practices are used not only for medicinal purposes but also for metallurgical and other practical applications [8]. By studying these texts, we can identify early examples of chemical techniques that align with modern principles of green chemistry, such as the use of renewable resources and the minimization of waste and energy consumption [9].

This exploration can provide valuable historical context and deepen our understanding of the evolution of chemical thought. Green chemistry, a contemporary movement aimed at designing products and processes that reduce or eliminate hazardous substances, shares several principles with ancient Vedic practices [10]. The Vedic emphasis on harmony with nature, the use of natural materials, and the pursuit of sustainable practices are echoed in the twelve principles of green chemistry, which include preventing waste, designing safer chemicals, and using renewable feedstocks. By examining the parallels between these ancient practices and modern principles, we can gain insights into how sustainable practices have evolved and how ancient wisdom can inform current and future scientific endeavors. The integration of ancient alchemical wisdom with modern scientific research presents both opportunities and challenges [11]. Ancient texts can inspire innovative approaches to sustainability, offering alternative perspectives and solutions to contemporary problems. However, translating these ancient practices into modern contexts requires careful consideration of historical, cultural, and scientific factors [12]. The vast corpus of Sanskrit literature, particularly the Vedic texts, represents a rich repository of ancient knowledge that continues to engage scholars across disciplines. Among its many contributions, the chemical insights embedded within these texts offer valuable perspectives on the early foundations of green and sustainable chemistry. This manuscript examines the alchemical and chemical knowledge preserved in Vedic literature and evaluates its relevance to contemporary sustainable chemical practices. By systematically comparing these ancient insights with modern green chemistry principles, the study highlights how Vedic thought may have anticipated key aspects of environmentally responsible chemical design. In doing so, it aims to bridge historical knowledge systems with contemporary scientific frameworks, fostering interdisciplinary understanding and underscoring the role of ancient wisdom in shaping modern chemical and environmental ethics. To promote interdisciplinary understanding, it is important to encourage a deeper appreciation of the historical roots of chemistry and recognize how ancient wisdom can inform modern scientific and environmental ethics.

GREEN AND SUSTAINABLE CHEMISTRY THROUGH A VEDIC LENS

The Vedic period, spanning roughly from 1500–500 BCE during history, produced a body of knowledge that encompasses not only spiritual and philosophical teachings but also practical insights into the natural world [13]. The ancient Vedic texts, although not explicitly formulated as chemical treatises, embody foundational principles that closely align with modern green chemistry and the United Nations Sustainable Development Goals (SDGs). These texts consistently emphasize harmony with nature, conservation of natural resources, and sustainable modes of living, concepts that strongly resonate with the objectives of green chemistry to minimize hazardous substances and reduce environmental impact. The integration of such ancient insights with contemporary green chemistry practices offers a meaningful pathway toward advancing sustainable development at both conceptual and practical levels. From the perspective of green chemistry, several parallels emerge. Vedic literature advocates the judicious and respectful use of natural resources, reflecting the green chemistry emphasis on renewable feedstocks, waste prevention, and resource efficiency [14]. Similarly, the Vedic principle of living in balance with nature aligns with the goal of designing safer chemical products and processes that minimize toxicity and ecological harm [15]. Furthermore, the implicit notion of cyclical resource use found in Vedic teachings parallels modern circular economy concepts, wherein waste is minimized and materials are continuously reused, a core objective shared by both green chemistry and sustainability science [14]. These philosophical foundations also contribute directly to several

Sustainable Development Goals. The emphasis on purity and cleanliness in Vedic practices corresponds with SDG 6 (Clean Water and Sanitation), reinforcing the importance of reducing chemical contamination of water systems through environmentally benign processes [16]. The promotion of mindful consumption and efficient resource utilization aligns with SDG 12 (Responsible Consumption and Production), a principle central to both Vedic ethics and green chemistry frameworks [17, 18]. In addition, the Vedic worldview of ecological balance supports SDG 13 (Climate Action) by encouraging low-impact technologies, energy efficiency, and sustainable interactions with natural systems [16]. While Vedic texts primarily provide a philosophical and ethical foundation for sustainable practices, the practical realization of these principles through green chemistry is essential for achieving the SDGs in contemporary contexts. Integrating ancient wisdom with modern scientific methodologies can foster innovative, low-impact solutions to current environmental challenges in Figure 1. However, such integration must adopt a systems-thinking approach to ensure holistic progress, prevent unintended consequences, and balance environmental, social, and technological dimensions of sustainability [19].

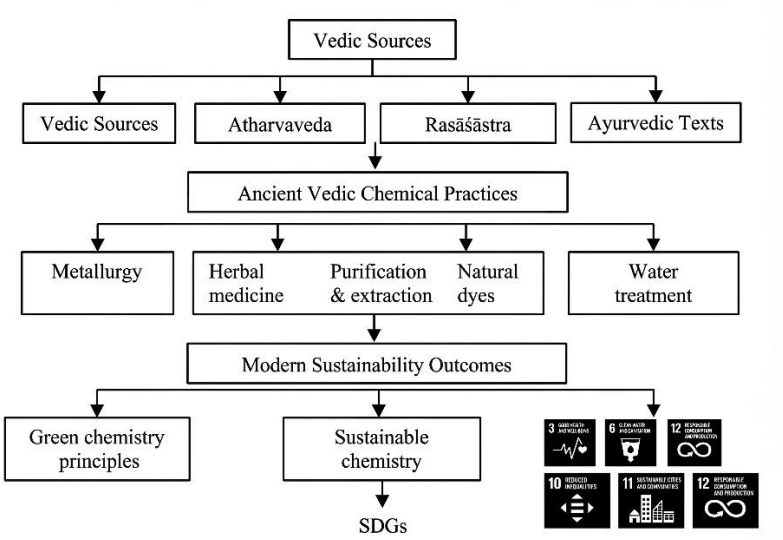

Figure 1. Conceptual linkage between vedic knowledge systems, ancient chemical practices, and modern sustainability outcomes.

The vast corpus of Sanskrit literature, particularly the Vedic texts, represents a rich repository of ancient knowledge that continues to engage scholars across disciplines. Among its many contributions, the chemical insights embedded within these texts offer valuable perspectives on the early foundations of green and sustainable chemistry [20]. Within this ancient wisdom lies a sophisticated understanding of chemical processes, often intertwined with spiritual symbolism and ritualistic practices. By examining these texts through the lens of modern scientific understanding, we can uncover valuable insights that may inform and inspire current efforts in green and sustainable chemistry. We explores several pivotal questions regarding the intersection of ancient Vedic texts and contemporary green and sustainable chemistry. What chemical insights can be gleaned from Vedic texts, and how do they relate to the concepts of green and sustainable chemistry?

This inquiry seeks to identify specific chemical knowledge or practices described in Vedic texts and analyze their relevance to the principles of green chemistry, such as reducing waste, using renewable materials and minimizing energy consumption.

- How do the alchemical practices described in Vedic texts align with the goals of contemporary sustainable development?

This question aims to explore whether the intentions behind ancient alchemical practices, such as the pursuit of harmony with nature or the transformation of substances, resonate with the goals of sustainable development as defined by modern environmental science.

- Does the study of Vedic texts contribute to a broader understanding of the historical evolution of chemical thought and its impact on modern green chemistry?

This question investigates the historical significance of Vedic texts in the development of chemical knowledge and their potential to inform current discussions on the philosophy and practice of green chemistry.

- What are the implications of integrating ancient alchemical wisdom with modern scientific research, particularly in the realm of green and sustainable chemistry?

This question explores the potential benefits and challenges of incorporating historical perspectives into contemporary scientific research and education, focusing on how ancient texts might inspire innovative approaches to sustainability. The intersection of ancient wisdom and modern science has gained increasing attention in recent years, as researchers have sought innovative solutions to pressing environmental challenges.

This manuscript explores the alchemical knowledge preserved in Vedic literature and examines its relevance to contemporary sustainable chemical practices. By highlighting how ancient wisdom can inform modern green chemistry, the study seeks to deepen our understanding of the historical roots of sustainable science while inspiring new directions for research and application aimed at sustainable development.

VEDIC LITERATURE: AN OVERVIEW TOWARDS CHEMISTRY

Historical Context

Vedic texts are among the oldest literary works in the world, dating back to approximately 1500 BCE. [21] They provide valuable insights into the early development of human thought, including concepts related to matter, transformation, and the natural world, which are precursors to later chemical theories [22].

Philosophical Foundations

The Vedas contain philosophical ideas that relate to the nature of existence and the material world. These ideas can be seen as the philosophical underpinnings of later scientific inquiry, including chemistry. By studying these texts, we can understand the early philosophical frameworks that influenced the development of chemical thought [23, 24].

Cultural Contributions

The study of Vedic texts highlights the contributions of ancient Indian civilization to the development of chemical knowledge. This is important for recognizing the multicultural origins of science and the global exchange of ideas that have shaped the evolution of chemical thought [25, 26].

Ethnobotanical Knowledge

Vedas also contain information about plants and their uses, which can contribute to the field of ethnobotany and the understanding of how ancient societies utilized natural resources. This knowledge is relevant to the study of chemical ecology and the history of medicine [27, 28].

Alchemical Precursors

Vedas and other ancient Indian texts contain references to metals, minerals, and other substances, as well as processes that resemble early forms of alchemy. Analyzing these references can help trace the origins of alchemy and its evolution in the systematic study of chemistry[29, 30].

Cumulative Chemical Knowledge : Understanding the chemical insights in Vedic texts helps establish historical continuity between ancient knowledge systems and the development of modern chemistry. This shows that the evolution of chemical thought is a cumulative process that builds on the observations and theories of many cultures over millennia [31, 32].

Interdisciplinary Insights

By examining Vedic texts, scholars can draw connections between religion, philosophy, and science, demonstrating how these disciplines have interacted with and influenced each other throughout history.

Vedic literature comprises four principal texts: Rigveda, Yajurveda, Samaveda, and Atharvaveda [33]. These texts, along with their associated commentaries and philosophical treatises, form the foundation of ancient Indian knowledge systems. The Rigveda, the oldest of the four, contains hymns that often describe natural phenomena in poetic language, whereas the Yajurveda focuses on sacrificial formulas and rituals. The Samaveda is primarily a collection of melodies, and the Atharvaveda includes spells and incantations, many of which are related to medicine and material transformations [34].

Each of these texts contributes uniquely to our understanding of ancient chemical knowledge:

1. *Rigveda:* Contains hymns describing natural phenomena, including references to metals, alloys, and celestial events that may have chemical significance [35]
2. *Yajurveda:* Provides detailed instructions for various rituals, many of which involve the manipulation of materials and substances, offering insights into early chemical processes [36].
3. *Samaveda:* While primarily focused on melodies, it includes references to the preparation of soma, a ritualistic drink that has been the subject of much scholarly debate regarding its chemical composition [37].
4. *Atharvaveda:* Offers a wealth of information on medicinal plants, minerals, and their applications, serving as a precursor to Ayurvedic medicine and providing an advanced understanding of natural product chemistry [38].

The emphasis on harmony with nature and responsible use of natural resources in Vedic literature reflects early ethical foundations that parallel modern sustainability principles embedded in SDG 12 and SDG 15, reinforcing the role of traditional knowledge systems in sustainable development discourse in Figure 2.

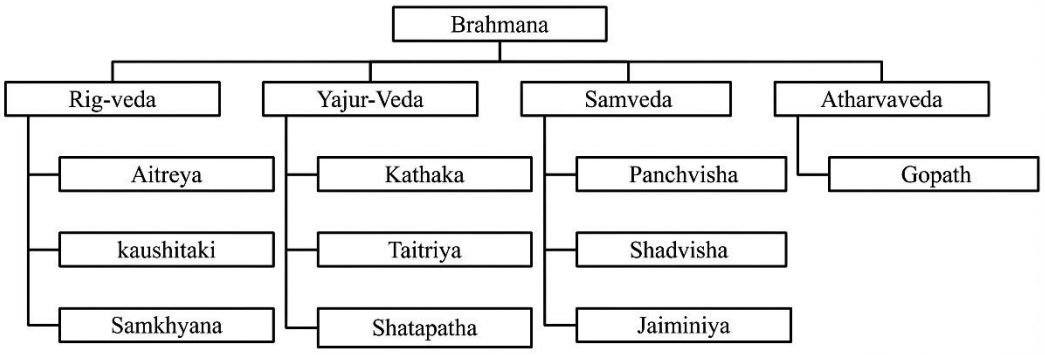

Figure 2. Hierarchical structure of the vedas and their associated brahmana texts.

ANCIENT ALCHEMY IN VEDIC TEXTS

The concept of alchemy in Vedic texts differs significantly from the Western notion of transmuting base metals into gold. Instead, it encompasses a broader understanding of material transformations, often with spiritual undertones. The terminology used in these texts often employs metaphors and analogies, requiring careful interpretation to discern the underlying chemical principles [39]. One of the most intriguing aspects of Vedic alchemy is the concept of "rasa," which can be translated as "essence"

or "juice." In alchemical contexts, rasa refers to mercury, which is considered a fundamental substance capable of transmuting other materials. The use of mercury in Vedic alchemy highlights an early understanding of metal amalgamation and purification processes [40].

The preparation of "soma," a sacred drink mentioned frequently in the Rigveda, has been the subject of extensive scholarly debate. Some researchers argue that the preparation of soma involves complex extraction and purification processes, suggesting an advanced understanding of chemical techniques [41]. While the exact composition of soma remains uncertain, the detailed descriptions of its preparation and effects provide sophisticated knowledge of plant-based chemistry and extraction methods. Although framed within symbolic and spiritual narratives, these alchemical practices reflect early attempts at material efficiency and controlled transformation, concepts that align with contemporary sustainability goals such as SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) through minimized waste and resource-conscious processes.

CHEMICAL INSIGHTS IN VEDIC LITERATURE

Metallurgy and Material Science

Vedic texts reveal sophisticated knowledge of metallurgy. The Rigveda mentions gold, silver, copper, and iron, indicating familiarity with these metals and their properties [42]. The texts also describe various alloys and their preparation methods, revealing an understanding of material science that has advanced over time. For example, the concept of "triloha," a three-metal alloy mentioned in Vedic texts, demonstrates an understanding of how combining metals can produce materials with enhanced properties. This knowledge laid the foundation for the later development of advanced metallurgical techniques in ancient India, such as the creation of the famous Delhi Iron Pillar, which has shown remarkable corrosion resistance for more than 1600 years [43]. The durability and corrosion resistance observed in ancient metallurgical practices underscore an implicit commitment to material longevity and resource conservation, aligning with SDG 12 and contributing indirectly to SDG 13 by reducing the need for repeated material production.

Herbal Medicine and Natural Products

The Atharvaveda, in particular, contains extensive information on medicinal plants and their applications. This knowledge forms the basis of Ayurveda, the traditional Indian system of medicine. The text describes methods of preparing herbal remedies, including extraction, decoction, and fermentation processes, which align with the principles of green chemistry in their use of natural, renewable resources [44]. One notable example is the use of neem (Azadirachta indica) in Vedic medicine. The Atharvaveda describes various medicinal applications of neem, including its use as an antiseptic and pesticide. Modern research has confirmed many of these properties, leading to the development of neem-based products for sustainable agriculture and medicine [45]. The reliance on plant-based remedies and biodegradable materials directly supports SDG 3 (Good Health and Well-Being) while promoting biodiversity conservation and sustainable land use in line with SDG 15 (Life on Land).

Environmental Awareness and Sustainability Concepts

Vedic literature often emphasizes the interconnectedness of all natural elements, promoting a holistic view of the environment. This perspective aligns with modern sustainability concepts, encouraging respect for natural resources and mindful consumption [46]. The concept of "Rita," or cosmic order, in Vedic philosophy emphasizes the importance of maintaining balance in nature. This idea resonates with modern ecological principles and the concept of sustainable development. Vedic texts advocate practices that we consider environmentally friendly, such as the use of natural fertilizers and pest control methods in agriculture [47]. This ecological worldview mirrors modern sustainability ethics and strongly aligns with SDG 13 (Climate Action) by emphasizing environmental balance, as well as SDG 15 through the protection of natural ecosystems.

Purification and Extraction Techniques

Various Vedic rituals involve purification processes that can be interpreted as early forms of chemical separation and extraction techniques. For example, the process of preparing ghee (clarified butter) involves separation of milk components, which can be seen as a rudimentary form of fractional distillation [48]. The Vedic practice of "soma pavamana," or the purification of soma, describes a complex process of filtering and refining the sacred drink. This process, while shrouded in ritual, demonstrates an understanding of separation techniques and the concept of purification through multiple stages, which is fundamental to many modern chemical processes [49]. Traditional purification techniques based on filtration, solar exposure, and natural separation processes demonstrate early low-energy treatment methods that resonate with SDG 6 (Clean Water and Sanitation) **and** SDG 7 (Affordable and Clean Energy)**.**

BRIDGING ANCIENT WISDOM WITH MODERN GREEN AND SUSTAINABLE CHEMISTRY

The principles of green chemistry, as defined by Anastas and Warner, find surprising parallels in Vedic chemical practices [50]. For example, the use of renewable resources, the minimization of waste, and energy efficiency are concepts that align with both ancient Vedic practices and modern green chemistry principles.

- *Case Study 1:* The Vedic practice of using natural dyes extracted from plants for coloring textiles aligns with modern efforts to develop sustainable, nontoxic alternatives to synthetic dyes. The use of indigo, derived from the Indigofera tinctoria plant, is a prime example of a traditional dye that has attracted renewed interest in sustainable textile production [51].
- *Case Study 2:* The Vedic understanding of water purification, as described in texts such as the Sushruta Samhita, includes methods such as boiling, sun exposure, and filtration through charcoal. These methods align with modern water treatment principles and provide an early understanding of water quality and purification techniques [52]. These parallels reinforce the contribution of ancient Vedic practices to contemporary sustainability frameworks, particularly SDG 12**,** SDG 13, and SDG 7, through environmentally benign and energy-efficient chemical methodologies.

CHALLENGES AND OPPORTUNITIES IN INTERPRETING VEDIC CHEMICAL KNOWLEDGE

Interpreting Vedic texts for chemical insights presents several challenges. The symbolic and often mystical language used requires careful analysis to distinguish between metaphorical descriptions and actual chemical processes. Additionally, the lack of standardized terminology and the evolution of language over millennia complicate accurate translations [53].

However, these challenges also present opportunities for interdisciplinary research, combining expertise from linguistics, chemistry, archaeology, and history to decipher and contextualize Vedic chemical knowledge. Advanced analytical techniques, such as archaeometallurgy and phytochemical analysis, can provide empirical evidence to support or refute interpretations of Vedic chemical processes.

IMPLICATIONS FOR CONTEMPORARY GREEN AND SUSTAINABLE CHEMISTRY

Integrating Vedic chemical insights into modern research paradigms supports a systems-based approach to sustainability, advancing SDG 3 through safer chemical design, SDG 12 through circular resource use, and SDG 13 by reducing environmental and climatic impacts of chemical processes. The study of Vedic chemical insights offers more than historical interest; it has the potential to inspire new directions in green and sustainable chemistry research. The holistic approach to nature found in Vedic texts encourages a systems thinking approach to chemistry, considering the broader environmental impact of chemical processes. Moreover, the emphasis on using natural, renewable resources in Vedic

practices aligns with current efforts to develop biobased chemicals and materials. The ancient knowledge of herbal medicine preserved in these texts may also guide the search for new pharmaceutical compounds from natural sources. For example, the safe use of copper as an antimicrobial agent has found new relevance in the development of antibacterial surfaces for healthcare settings. Similarly, the traditional use of turmeric (Curcuma longa) in Vedic medicine has inspired modern research into its anti-inflammatory and antioxidant properties, leading to the development of curcumin-based therapies.

GOALS OF CONTEMPORARY SUSTAINABLE DEVELOPMENT

Sustainable development aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. It encompasses three core components: economic growth, social inclusion, and environmental protection. The United Nations' Sustainable Development Goals (SDGs) provide a blueprint for a more sustainable and equitable world, addressing issues such as climate action, responsible consumption and production, and life below water and on land.

Alignment between Vedic Alchemy and Sustainable Development

- *Harmony with nature:* Vedic alchemy often emphasizes a deep connection with nature and the balance of natural forces. This aligns with the sustainable development goal of living in harmony with the environment.
- *Resource efficiency:* Ancient alchemical practices may have focused on the transformation and enhancement of materials, which could be seen as an early form of resource efficiency and circular economy principles.
- *Herbal Medicine and Sustainable Health:* The use of herbs and natural substances in Vedic texts for medicinal purposes is akin to promoting sustainable health practices, which is part of the contemporary sustainable development agenda.
- *Minimization of Waste:* Alchemical processes that aim to purify or transform substances could be interpreted as early attempts to minimize waste and use resources more effectively, which is a key aspect of sustainable development.
- *Cultural and Spiritual Values:* The spiritual and cultural values embedded in Vedic texts can contribute to the social inclusion aspect of sustainable development by preserving traditional knowledge and promoting cultural diversity.
- *Innovation and Knowledge Transfer:* The experimental and inquisitive nature of alchemy can inspire modern innovations in sustainable technologies and practices, emphasizing the importance of knowledge transfer across generations in Figure 3.

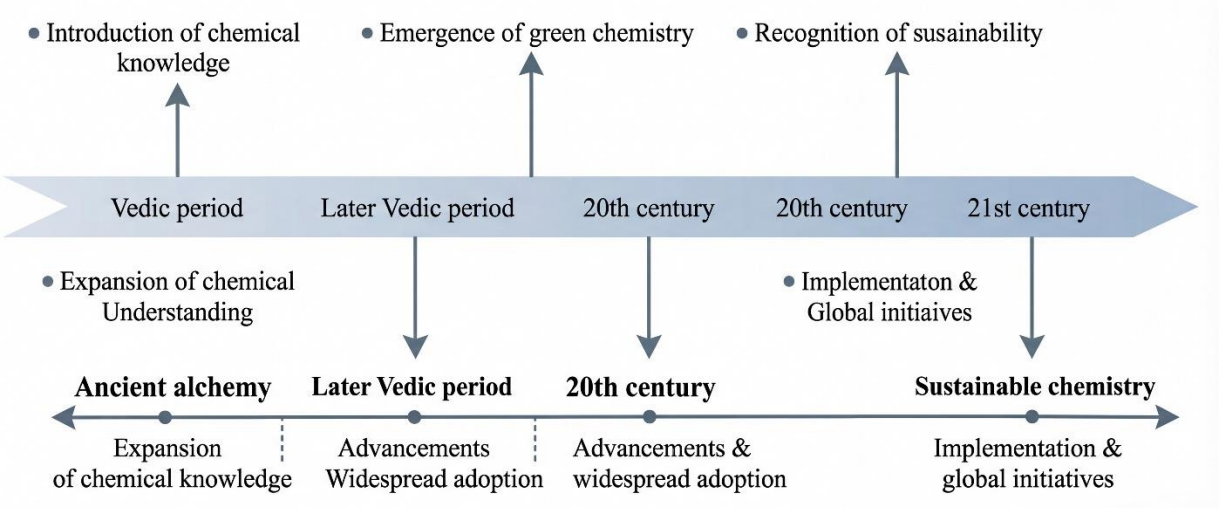

Figure 3. Evolution of chemistry from ancient alchemy to sustainable and green chemistry across historical periods.

A Holistic Approach to Environmental Stewardship: Exploring the Synergy between Green Chemistry Principles, Vedic Chemistry Traditions, and Sustainable Development Goals

Correlating the 12 principles of green chemistry with Vedic chemistry and the Sustainable Development Goals (SDGs) can provide a holistic view of sustainable practices. Let us explore this in an innovative way:

By aligning the 12 principles of green chemistry with Vedic practices and the SDGs, we can identify a unified approach toward sustainable development that integrates ancient wisdom with modern scientific goals in Table 1. This holistic view not only preserves our environment but also promotes health, innovation, and sustainable growth.

Table 1. Correlation between green chemistry principles, Vedic chemistry concepts, and sustainable development goals (SDGS).

S.No.	Green Chemistry Principles	Vedic Chemistry	SDG Goals Correlation
1	Prevention of Waste It is better to prevent waste than to treat or clean up waste after it has been created.	The concept of "Yajna" involves performing rituals that promote balance and harmony in nature, thereby preventing environmental degradation. The Vedic approach emphasizes minimal waste, focusing on the complete use of resources. For example, the practice of Ayurveda uses whole plants, ensuring all parts are utilized.	SDG 12 (Responsible Consumption and Production): Minimizing waste promotes sustainable production patterns. SDG 6 (Clean Water and Sanitation): Reducing pollutants helps maintain water quality.
2	Atom Economy Design synthetic methods to maximize the incorporation of all materials used into the final product.	Alchemical texts like Rasashastra emphasize processes that maximize yield and minimize waste, using efficient methods. The principle of "Ashraya" or resourcefulness in Vedic practices ensures that every component of a ritual or process is utilized efficiently, mirroring the idea of minimizing waste.	SDG 9 (Industry, Innovation, and Infrastructure):* Efficient processes lead to sustainable industrialization. SDG 12 (Responsible Consumption and Production):* Promotes resource efficiency.
3	Less Hazardous Chemical Syntheses Design synthetic methods to use and generate substances with little or no toxicity to human health and the environment.	The use of natural and less toxic substances in traditional practices, such as herbal remedies and organic dyes. Emphasizes the use of natural substances like herbs and minerals (Ayurveda) for health and wellness, avoiding harmful synthetic chemicals.	SDG 3 (Good Health and Well-being): Reduces exposure to harmful chemicals. SDG 15 (Life on Land):* Protects terrestrial ecosystems by reducing chemical runoff.
4	Designing Safer Chemicals Design chemical products to be fully effective yet have little or no toxicity.	Use of natural, nontoxic ingredients in traditional medicines and practices. Utilizes "Aushadhi" or medicinal plants to treat ailments with minimal side effects, focusing on holistic health.	SDG 3 (Good Health and Well-being):* Ensures safety in chemical use. SDG 14 (Life Below Water):* Protects aquatic life from toxic substances
5	Safer Solvents and Auxiliaries Avoid the use of auxiliary substances wherever possible and make them innocuous when used.	Utilizes water and milk as solvents in various rituals and medicinal preparations, emphasizing safety and nontoxicity.	SDG 6 (Clean Water and Sanitation):* Reduces water contamination. SDG 12 (Responsible Consumption and Production):* Promotes safer production processes
6	Design for Energy Efficiency Minimize energy requirements of chemical processes and	Techniques like solar drying and fermentation, which require minimal energy input.	SDG 7 (Affordable and Clean Energy):* Encourages energy-efficient practices.

	conduct them at ambient temperature and pressure.	Practices like "Suryanamaskar" (sun salutation) and the use of solar energy in cooking (solar cookers) reflect energy efficiency and the use of renewable resources.	SDG 13 (Climate Action):* Reduces carbon footprint by lowering energy consumption.
7	Use of Renewable Feedstocks Use raw materials that are renewable rather than depleting.	Relies on plant-based materials like neem, tulsi, and turmeric for various applications, highlighting the use of renewable resources..	SDG 12 (Responsible Consumption and Production):* Encourages sustainable resource use. SDG 15 (Life on Land):* Supports sustainable land use and agriculture.
8	Reduce Derivatives Minimize or avoid the use of blocking or protecting groups or any temporary modification .	The principle of simplicity in Vedic rituals avoids unnecessary complexity, akin to reducing derivatives in chemical processes.	SDG 9 (Industry, Innovation, and Infrastructure):* Streamlined processes enhance sustainability. - *SDG 12 (Responsible Consumption and Production):* Reduces unnecessary steps in production
9	Catalysis Use catalytic reactions to increase efficiency and reduce waste.	Utilizes catalysts in Ayurvedic medicine, like cow's ghee to enhance the efficacy of medicinal herbs, showcasing an understanding of catalytic effects.	SDG 9 (Industry, Innovation, and Infrastructure):* Promotes innovative industrial processes. - *SDG 12 (Responsible Consumption and Production):* Enhances process efficiency and sustainability.
10	Design for Degradation Design chemical products so they breakdown into innocuous products after use.	Emphasizes the use of biodegradable materials like clay, leaves, and natural fibers in daily life and rituals, ensuring minimal environmental impact	SDG 14 (Life Below Water):* Prevents marine pollution from persistent chemicals. SDG 15 (Life on Land):* Protects terrestrial ecosystems from degradation.
11	Real-time Analysis for Pollution Prevention Develop analytical methodologies to allow for real-time, in-process monitoring and control.	Regularly practices environmental assessment through observation of natural cycles and phenomena (e.g., observing weather patterns), aligning with real-time analysis to prevent adverse impacts	SDG 9 (Industry, Innovation, and Infrastructure):* Enhances process monitoring. SDG 12 (Responsible Consumption and Production):* Supports responsible management of production.
12	Inherently Safer Chemistry for Accident Prevention Design substances and the form of a substance to minimize potential for chemical accidents.	The principle of "Ahimsa" (nonviolence) extends to nonharmful practices in all aspects of life, including chemistry, ensuring safer processes and products	SDG 3 (Good Health and Well-being):* Prevents health hazards. SDG 8 (Decent Work and Economic Growth):* Promotes safe working environments.

CONCLUSION

This exploration of chemical insights in Vedic texts reveals a rich tapestry of ancient wisdom that resonates with modern principles of green and sustainable chemistry. While it would be anachronistic to claim that Vedic practitioners possessed a modern understanding of chemistry, their holistic approach to material transformations and respect for natural processes offer valuable lessons for contemporary scientists. Given that we face global challenges related to sustainability and environmental protection, the wisdom preserved in ancient texts such as the Vedas may provide inspiration and guidance. By bridging the gap between ancient alchemical knowledge and modern scientific understanding, we open

new avenues for innovation in green and sustainable chemistry. Further research is needed to fully uncover and interpret the chemical knowledge embedded in Vedic texts. This endeavor requires an interdisciplinary approach that combines expertise from various fields to decode the symbolic language and contextualize the practices described. As we continue to explore this ancient wisdom, we find that the past holds keys to a more sustainable future in chemistry and beyond. The integration of Vedic chemical insights into modern research paradigms has the potential to yield novel approaches to sustainable chemistry. By viewing chemical processes through the lens of ancient wisdom, we may discover innovative solutions to contemporary challenges in areas such as waste reduction, energy efficiency, and the development of eco-friendly materials. In conclusion, the study of Vedic alchemy and its relevance to green and sustainable chemistry represents a fascinating intersection of ancient wisdom and modern science. As we continue to unravel the mysteries of Vedic texts, we find that these ancient insights contribute greatly to the development of a more sustainable and environmentally conscious approach to chemistry in the 21st century and beyond. Viewed through the lens of the United Nations Sustainable Development Goals, Vedic chemical knowledge offers valuable perspectives that support SDGs 3, 6, 7, 12, 13, and 15**,** reinforcing the relevance of traditional wisdom in addressing contemporary sustainability challenges. This integration highlights the potential of historically informed approaches to guide future innovations in green and sustainable chemistry.

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