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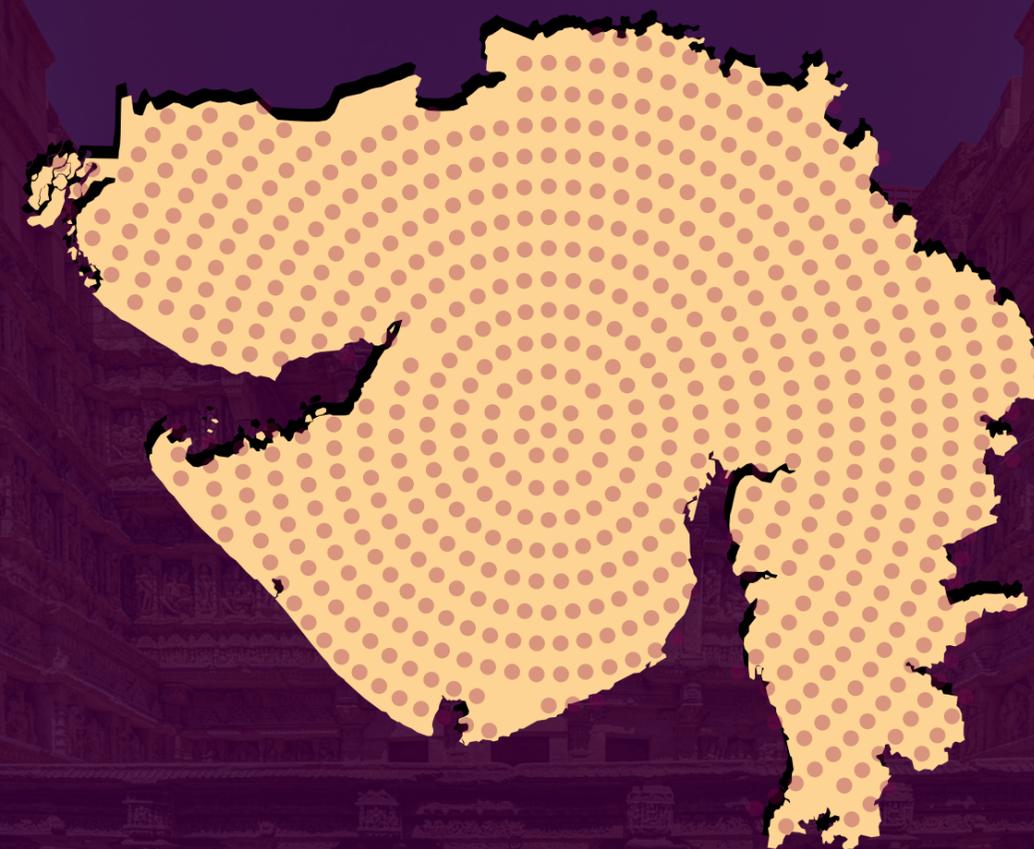
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# science VIEW

Student's Magazine, Issue: 14, 2026



# દેવસા

The Science Behind  
**Gujarat's Festive Spirit**





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## Message from Editor's Desk

It gives me immense pleasure to present the 14th Edition of Science View Magazine, centered on the theme "The Science Behind Gujarat's Festive Spirit." Gujarat's festivals are renowned for their color, rhythm, devotion, and collective joy, but beyond their cultural brilliance lies a rich foundation of science, management, and technology that often goes unnoticed. This special edition aims to uncover those hidden dimensions and present festivals as dynamic platforms of applied knowledge.

The articles featured in this issue are the result of sincere efforts by the students and faculty of GSFC University, who have skillfully blended scientific reasoning with cultural storytelling. Their work reflects curiosity, academic discipline, and a deep respect for India's rich festive heritage, making this edition both informative and engaging for a diverse readership. I extend my heartfelt appreciation to all contributors, editors, designers, and coordinators whose dedication has shaped this issue. I also thank our readers for their continued trust and encouragement. We hope this edition inspires you to celebrate festivals with renewed awareness, curiosity, and pride—recognizing them not just as cultural events, but as living examples of science, management, and technology in everyday life.

-Dr. Aditya Puranik  
Sr. Assistant Professor,  
Chief Editor Science View Magazine

## Message from Designer's Desk

We express our sincere gratitude to GSFC University for entrusting us with the opportunity to serve as the Concept Designer of the Science View Magazine from Edition 10 through Edition 14. This journey has been both professionally enriching and creatively fulfilling, allowing us to contribute meaningfully to the university's official publication. As this edition marks the final issue designed by us, we take this moment to acknowledge with deep appreciation the guidance, encouragement, and unwavering support extended to us throughout this tenure. We are especially thankful to Dr. Mihir Trivedi for his continued trust and vision. Our heartfelt thanks also go to President Shri P. K. Taneja, IAS (Retd.) , Provost Dr. G. R. Sinha, Campus Director Shri Mahesh Barot, Assistant Director Shri Naren Acharya, and Dean DOST-AI Dr. K. Santoshkumar for their leadership and constant motivation. We also gratefully acknowledge the valuable support of Ms. Priyanka Yadav, Ms. Sachiyanika Srivastava, and our esteemed former faculty member Dr. Priya Goel, whose guidance and nurturing approach played a significant role in shaping our journey and helping us achieve success as designers of GSFC University's official magazine. Designing Science View has been an honor and a learning experience that we will always cherish. We leave with a sense of pride, gratitude, and best wishes for the continued growth and excellence of the magazine in the years to come.

-Dev Patel & Foram Mistry  
Concept Designer,  
Science View Magazine

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# Climate Science and Seasonal Timing of Gujarat's Major Festivals

Aayush Varia, M.Sc. Organic Chemistry, Semester IIV, School of Science

Gujarat's cultural calendar is a refined expression of its long experience in environmental observation and adaptation and its resultant biological entrainment with nature's cycles. Gujarat's traditional cultural calendar had synchronised its festivals into the transition phases dictated by the solar cycle, and the monsoons and temperature changes long before the discovery of the science of climate change. While the traditional Gujarat's cultural calendar had synchronised its festivals into the transition phases to suit agricultural and comfortable purposes, current advances in the science of climate and chronobiology offer sound reasons for the relevance of such a calendar to the physiology of humans.

The Gujarat environment has three major seasons, namely summer, monsoons, and winter, each causing a unique physiological effect on the human body. Summer is too hot and dry, causing dehydration, heat strokes, and loss of physical stamina. Monsoons are humid, with microorganisms and digestive issues. Winter has moderately cool temperatures, low microorganisms, and better cardiovascular conditions. Scientifically speaking, festivals in Gujarat are mostly avoided in the peak summer seasons, where high temperatures are associated with increased cortisol levels, increased oxidative stress, and reduced efficiency of the immune system. The reasoning behind the concentration of festivals in the post-monsoon and winter seasons relates to the knowledge of comfortable thermal zones for the preservation of physical efficiency and stamina.

One of the most scientific festivals in terms of significance is that of "Uttarayan" or "Makar Sankranti" in the middle of January, marking the beginning of the Sun's journey in a northerly direction, thus adding more time to the daylight hours. This phenomenon holds a vital role in relation to our own "body clock" or "circadian rhythms" in regulating our bodily functions, thereby having a positive effect on the balance between melatonin and "serotonin" hormones, resulting in improved "mood stability". There have been scientific proofs of research-based practices that have demonstrated "exposure to more sunlight" in winters being an effective remedy in treating "Seasonal Affective Disorder" (SAD) effectively and increasing the "Production of necessary vitamin D in our bodies" in the most natural way, contributing in a major way to "strong bones, an immune system, and sound functioning of our bodily hormones". This scientific festival's activity of performing "outdoor exercises like kite-flying" pairs directly in line with this scientific benefit of this festival. Another major scientific aspect related to this festival used to be the eating of traditional foods like "sesame seeds, peanuts, or jaggery" which are extremely beneficial to our bodies consisting of "healthy fats, Iron, and Antioxidants" that protect our "body warmth" and "metabolism-boosting effect" in "cold climatic conditions" in our bodies.



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Monsoon festivals like Janmashtami are observed during a biologically fragile time. Humid and temperature fluctuations, which occur during monsoons, may lower the 'digestive fire' ('Agni' according to Ayurvedic medicine) and may make one more vulnerable to infections. Scientifically, there is increased growth of microbes during monsoons in water and food materials. Fasting and appropriate dieting that is practiced during Janmashtami help cut down the 'digestive burden,' 'modulate intestinal microbiota,' and 'curb risks of food and water-borne infections.' These practices indicate the early development of a 'preventive health' modality that is suited to seasonal patterns of diseases. Thus, the Rann Utsav of Kutch is a real example of optimization of human comfort by climate. This event takes place only during winter months and avoids the flooding of the salt desert during the monsoon and extreme summer heat. The dry air, stable atmospheric pressure, and low humidity in winter significantly minimizes respiratory stress and heat exhaustion. Nighttime cultural activities under clear skies further help maintain human circadian health in terms of natural light-dark cycles. On the other hand, environmental psychology has revealed that a view of open landscapes and natural environments reduces cortisol levels, improves clarity of mind, and increases emotional well-being.

Seasonal fairs like the Shamlaji Fair and Bhavnath Fair are similarly organised when climatic conditions are more stable, resulting in less exertion for devotees. Long-distance pilgrimages on foot are feasible in cooler climatic conditions, and this helps to reduce dehydration, muscular exhaustion, and cardiovascular strain. This festival is also a good source of social bonding, an important aspect that modern neuroscience attributes to oxytocin release in the brain. All these festivals are based on the conventional lunisolar calendar, which was a climate-resilient system in itself. By monitoring the solar changes, lunar cycles, and seasons, the ancient Indian lunisolar calendar was able to harmonise people's lives with the environment. Contemporary chronobiology has validated that synchronising the environment with internal body clocks can optimise sleep quality, metabolism rates, immunity levels, and intellectual performance. Therefore, the timings of the Gujarat festivals maintain a perfect blend between traditional knowledge and biology.

Finally, it can be seen that in season-related festivities like those of Gujarat, there is a deep link with various science fields like awareness about the climate, solar science, physiology, and environmental health. These are practices that have been long ingrained in tradition and have been systematically aligned in order to maximise human energy, minimize disease risks, and ensure psychological health through a complex knowledge of nature's dynamics. These, long before the language of science had been formalised, had been representative of the perfect amalgamation between culture and science. In today's world, faced with issues like climate change and lifestyle diseases, this valuable blend between culture and science can thus prove to be nothing short of heavenly.



# A Night Written in the Stars and the Stones

Foram Mistry & Urmil Patel, M.Sc. Organic Chemistry, Semester IIV,  
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Have you ever witnessed a place where history does not lie silent in books but walks barefoot among people? Where mythology is not a distant tale but a living breath in the air? At the foothills of Girnar, as the night deepens on Mahashivratri, Bhavnath does not merely host a fair, it reenacts a civilizational memory older than time itself. Long before calendars marked festivals and governments managed gatherings, sages chose this land for penance. It is believed that Lord Shiva himself manifested here as Bhavnath Mahadev, making this sacred ground one of the rare places where divinity and geography merge. The Girnar mountain range, ancient and unyielding, stands as a silent witness to eras gone by from the age of rishis and yogis to the reigns of Mauryas, Guptas, and Chalukyas. Emperor Ashoka's inscriptions etched on Girnar's rock face remind us that this land has always been more than terrain; it has been a spiritual compass for Bharat.

According to mythology, Mahashivratri marks the cosmic night when Shiva performed the Tandava, the dance of creation, preservation, and destruction. It is also the night when Shiva and Shakti unite symbolising the balance of consciousness and energy. At Bhavnath, this mythology finds form. The ritual of Nagar Pradakshina, the royal procession of Naga sadhus, is not a spectacle but a tradition that flows uninterrupted through centuries. Ash-smearing bodies, matted hair, and eyes fixed beyond the material world these ascetics represent renunciation in its purest form, reminding society of values long overshadowed by modern excess. As the sun sets, Bhavnath transforms. Temple bells echo against Girnar's cliffs, conch shells pierce the silence, and lakhs of devotees gather with copper kalash filled with holy water. The chants of "Har Har Mahadev" do not rise in isolation; they merge into a collective consciousness. Here, faith is not hurried. People walk miles, wait hours, and sleep under open skies not out of compulsion, but surrender. In an age where devotion is often digitised, Bhavnath remains stubbornly human.

Historically, the Bhavnath Fair has also been a meeting ground of cultures, sects, and philosophies. Shaivites, Vaishnavites, Nath yogis, Aghoris, and household devotees converge here without hierarchy. Kings once sought blessings here before battles; commoners still seek peace here after life's battles. The fair reflects India's unique civilizational trait unity without uniformity. No barricade separates belief systems; no doctrine competes for dominance. Shiva, the Adiyogi, embraces all. What makes Bhavnath extraordinary is not its scale, but its continuity. While civilizations elsewhere rose and fell, Bhavnath endured adapting yet unchanged. The rituals remain elemental: water, fire, ash, silence. Girnar's winds still carry stories of meditation and moksha. And on Mahashivratri night, when the cosmic alignment is believed to elevate human consciousness, Bhavnath becomes a bridge between the mortal and the eternal. What if faith was not only felt in the heart but also registered by the human nervous system? The Bhavnath Fair unfolds at the foothills of Girnar not merely because mythology placed Shiva here, but because this land itself behaves differently. Girnar is among the oldest mountain formations in India, composed of ancient igneous rocks that create a naturally stable geomagnetic environment. Such regions are known to calm neural activity, allowing the human mind to remain alert yet composed for long hours. This is precisely why sages, long before scientific instruments existed, chose this terrain for meditation and why Mahashivratri here feels deeper, quieter, and more intense than anywhere else.



What if the placement of temples and water bodies was not symbolic art but subconscious engineering? The Bhavnath Mahadev temple does not stand alone; it shares an energetic dialogue with Mrugi Kund and Damodar Kund. Together, they form a natural triangular configuration, a geometry known in physics to stabilize and concentrate energy. Water acts as a conductor, rock as a stabilizer, and open land as a carrier. Without wires, walls, or machines, this landscape performs a function modern science is only beginning to articulate. What if the chosen date of Mahashivratri was a biological insight rather than a mythological coincidence? Occurring during the transition from winter to spring, Mahashivratri arrives when the human body undergoes subtle hormonal shifts. Sleep cycles fluctuate, mental clarity wavers, and the nervous system seeks recalibration. Staying awake with discipline on this night is a central practice of the Bhavnath Fair helps reset circadian rhythms and sharpen neural adaptability. What appears as ritual is, in reality, a physiological realignment with nature's calendar.

What if the presence of ash-smearing ascetics was not spectacle, but silent neuroscience? At Bhavnath, Naga sadhus are not peripheral figures; they are the axis of the fair. Neuroscience tells us that humans unconsciously mirror observed behavior through mirror neurons. Witnessing stillness slows the observer. Watching renunciation quietens inner noise. In a world addicted to stimulation, Bhavnath creates an environment of controlled sensory withdrawal, a rare psychological detox masked as devotion. What if the sacred kunds were nature's laboratories? The waters of Mrugi Kund and Damodar Kund flow and rest over igneous rock, enriching the surrounding air with negative ions known to reduce stress and improve oxygen absorption. Bathing before darshan cools the body, steadies the breath, and prepares the mind for prolonged focus. These kunds are not ornamental; they are physiological gateways that prepare pilgrims for the heightened consciousness Mahashivratri seeks to awaken.

What if the apparent crowd was actually a collective instrument? Bhavnath may appear chaotic to the eye, yet its rhythm is deeply ordered. Mantras replace noise, bells replace announcements, and movement follows ritual cycles rather than random flow. Such structured repetition is known to induce alpha and theta brain states the same states observed in deep meditation. As thousands chant in unison and focus on a single symbol of Shiva, their neural rhythms begin to synchronize, creating a shared psychological field rarely achieved in modern gatherings.

What if Bhavnath was never meant to entertain, but to recalibrate? Unlike other fairs in Gujarat that celebrate harvest, trade, or tourism, Bhavnath turns the gaze inward. It strips away excess and replaces it with discipline. It reduces stimulation to restore sensitivity. It does not distract the mind; it tunes it. And that is why Bhavnath cannot exist anywhere else, nor on any other day. Because Bhavnath on Mahashivratri is not simply a fair held in faith it is a convergence where geology supports biology, ritual supports neuroscience, and mythology quietly aligns with science. In this sacred pause at Girnar's foothills, humanity does not escape the world; it resets itself within it.

As the last echoes of conches fade and the Girnar hills settle back into their ancient stillness, it's worth pausing to reflect on why this year, Mahashivratri fell on February 15, 2026, a date guided not by convenience but by the rhythms of the lunar calendar the Chaturdashi tithi of Krishna Paksha in the month of Phalguna when the waning moon and cosmic alignment are believed to amplify spiritual awareness. This choice of night uniquely different from other lunar festivals blends mythology with celestial timing: it marks the divine union of Shiva and Shakti, the night when Lord Shiva is said to have performed the cosmic dance of creation and dissolution, and the moment when the universe tilts subtly toward introspection and balance. In Bhavnath, this celestial moment finds a home in earthly geology, human physiology, and collective consciousness. Here, science and faith do not compete; they converge. The ancient rocks and kund waters tune the body's rhythms, the geometric layout amplifies subtle energies, and the season's hormonal shifts make the night ideal for resetting the internal clock. In this convergence, Bhavnath is neither a festival of mere celebration nor a relic of tradition; it is a living, breathing experiment in aligning nature, astronomy, and human awareness. And as pilgrims return home with hearts steadier and minds quieter, one thing becomes clear: Bhavnath on Mahashivratri is not just an event in time it is a harmonised moment where human potential, cosmic cycles, and natural laws resonate as one.

# Where Tradition Meets Technology: The Science Of Sustainable Celebrations

Aditi Singh, B.Sc. Microbiology, Semester II, School of Science

## Development of Sustainable Technologies for Eco-Friendly Festival Decorations

The development of sustainable technologies for eco-friendly festival decorations has emerged as an important research area due to rising environmental concerns and a global shift toward conscious consumption. Festivals, while culturally significant, often generate large volumes of waste through single-use decorations, excessive energy consumption, and non-biodegradable materials. The primary objective of sustainable festival decoration strategies is therefore to minimize environmental impact across the entire lifecycle of decorative elements—from raw material sourcing and manufacturing to usage, reuse, and final disposal. Achieving this goal requires a multidisciplinary approach integrating eco-friendly materials, renewable energy technologies, reusable design strategies, and low-impact manufacturing practices.

## Sustainable Materials for Festival Decorations

A major focus of sustainable decoration research lies in replacing conventional plastics with biodegradable and renewable materials. Traditional festival decorations rely heavily on synthetic plastics, which contribute to environmental pollution, low recycling rates, and long-term accumulation in landfills and natural ecosystems. In contrast, eco-friendly alternatives include natural fibers, organic cotton, bamboo fiber, and biopolymers derived from renewable resources. These materials offer mechanical and functional properties comparable to conventional plastics while significantly reducing environmental harm. Many biopolymers are sourced from non-food biomass such as cellulose, lignin, reed, hemp waste, and agricultural residues, ensuring that material production does not compete with food resources. This makes them particularly suitable for large-scale decorative applications. Additionally, innovative materials such as eggshell powder (ESP) are being explored as sustainable fillers and reinforcements in biodegradable composites. These materials help address global challenges related to plastic waste and resource depletion and have already demonstrated effectiveness in applications such as eco-friendly food packaging, where structural integrity and safety are critical.

## Role of Additive Manufacturing (3D Printing)

Additive manufacturing, particularly 3D printing, has significantly enhanced the potential for sustainable festival decorations. By using biodegradable and biocompatible polymers, 3D printing allows the creation of intricate and customized decorative elements with minimal material wastage. This flexibility is especially valuable for festivals, where decorations are often theme-specific and temporary. 3D printing also supports on-demand production, reducing the need for large inventories and storage of mass-produced decorations. Although the initial investment in 3D printing equipment and specialized biodegradable filaments may be high, long-term benefits include reduced material waste, lower transportation costs, and enhanced customization, making it an efficient solution for sustainable decoration production.



### Renewable Energy Integration in Decorations

Beyond material innovation, renewable energy integration is essential for achieving truly sustainable festival decorations. Solar-powered lighting systems are among the most widely adopted solutions, reducing dependence on electricity generated from non-renewable sources. Solar lights are particularly suitable for outdoor festivals, offering ease of installation and long-term operational savings. Emerging energy-harvesting technologies further expand sustainability possibilities. Triboelectric Nanogenerators (TENGs) can convert mechanical energy from wind movement, vibrations, or human interaction into electrical energy. These devices are self-powered, affordable, and highly adaptable, making them suitable for temporary festival installations and interactive decorative displays. Recent developments in biopolymer-based TENGs (B-TENGs) enhance sustainability further by incorporating biodegradable materials into energy-harvesting systems. Flexible and intelligent triboelectric patches allow for dynamic decorations that respond to environmental or human activity without requiring external power sources, aligning well with eco-smart city concepts and sustainable event infrastructure.

### Low-Impact and Reusable Design Principles

Low-impact design principles play a critical role in minimizing the environmental footprint of festival decorations. These principles emphasize material efficiency, waste reduction, and end-of-life considerations such as reusability, recyclability, and biodegradability. Eco-design strategies commonly applied in sustainable packaging—such as reducing material thickness, eliminating unnecessary printing, and avoiding permanent adhesives—can be directly adapted to festival decorations. Reusable decoration designs are particularly important for promoting sustainability. Instead of single-use decorations, durable and modular components can be assembled, disassembled, stored, and reused across multiple events. Structural designs that eliminate permanent adhesives allow for easy repair, reconfiguration, and extended use. This approach aligns with the concept of structural reuse, where components are designed for a “second life,” similar to practices seen in industries such as wind-energy manufacturing.

### Bioplastics as Alternatives to Conventional Plastics

Bioplastics demonstrate significant potential to replace traditional plastics in festival decorations due to their biodegradability and derivation from renewable resources. Their adoption is critical for addressing environmental issues associated with conventional plastics, including improper disposal, ecosystem accumulation, and toxic emissions during degradation or incineration. Bioplastics derived from non-food biomass sources such as cellulose, lignin, reed, and hemp waste offer comparable performance to synthetic polymers while reducing dependence on fossil fuels. In contrast, widely used plastics like polyethylene terephthalate (PET) are produced through energy-intensive chemical processes involving ethylene glycol and terephthalic acid, highlighting the environmental burden that bioplastics aim to mitigate.

### Cost Implications of Sustainable Festival Decorations

Cost considerations play a crucial role in the adoption of sustainable festival decorations. While the initial investment in biopolymers, biodegradable composites, renewable energy systems, and 3D printing technologies may be higher than conventional single-use decorations, long-term economic benefits are significant. Reusable decorations reduce repeated procurement costs, while modular designs extend product lifespan and lower replacement expenses. Renewable energy systems such as solar lighting and TENGs reduce operational energy costs and minimize the need for temporary power infrastructure. Additionally, reduced waste generation leads to lower disposal and landfill costs. Although precise quantitative cost data are limited in existing literature, it can be reasonably inferred that sustainable decorations become economically favourable over multiple festival cycles. Further research involving comprehensive life-cycle cost analysis is required to establish direct comparisons with traditional decoration systems.

### Challenges and Future Directions

Despite substantial progress, challenges remain in the widespread adoption of eco-friendly festival decorations. These include performance limitations of biodegradable materials, higher upfront costs, limited durability in certain applications, and lack of consumer awareness. Addressing these challenges requires continued technological innovation, improved material engineering, policy support, and public education to encourage sustainable choices.



### Conclusion

The transition toward sustainable festival decorations represents a critical step in reducing the environmental impact of large-scale celebrations while preserving cultural vibrancy. The integration of biodegradable and renewable materials, reusable and modular design strategies, renewable energy technologies, and low-impact manufacturing methods provides a comprehensive framework for sustainability across the lifecycle of decorative elements. Although initial investments may be higher, long-term environmental and economic benefits—such as reduced waste, lower energy consumption, and extended product lifespan—make sustainable festival decorations a viable and responsible alternative. By adopting eco-friendly materials, reusable designs, and renewable energy solutions, festivals can move toward a circular economy model that balances aesthetics, functionality, and environmental responsibility, contributing to a more sustainable future for cultural celebrations.

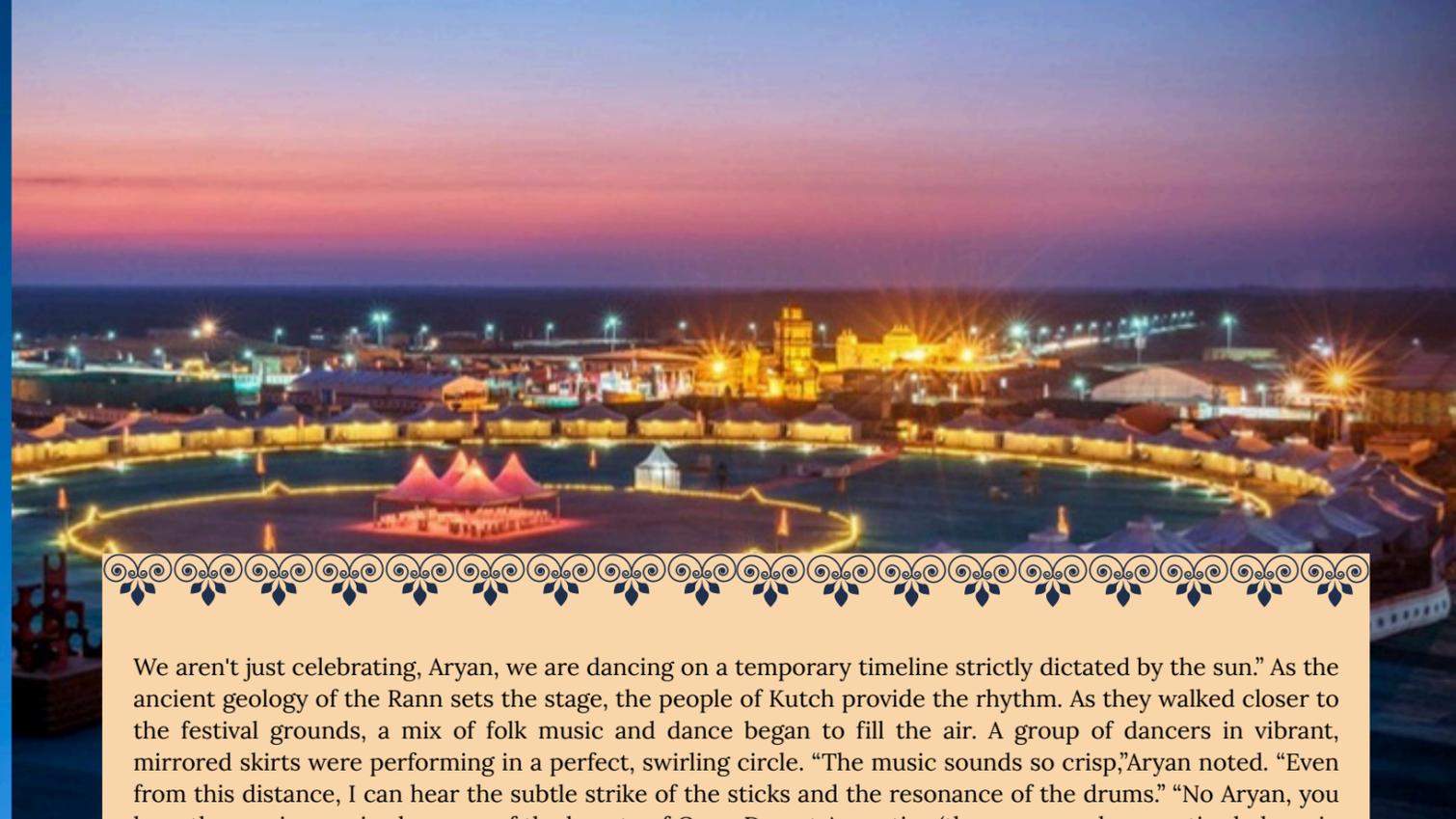
# Infinite Mirror: A Midnight Journey Through the Science of the Rann

Krishay Shah, B.Tech. CSE, Semester IV, School of Technology

Imagine a city of nearly 400 luxury tents that appears out of thin air, thrives for exactly 100 days, and then vanishes without leaving a single scar on the earth. In the heart of the Great Rann of Kutch, the largest district in India, where the ground is made of salt and the temperatures swing from scorching to freezing in hours, this isn't a mirage. It's the Rann Utsav. The jeep's headlights cut through the darkness so absolute it felt like a physical wall. As they neared the Tent City of Dhordo, a sprawling grid of white canvas began to glow under the stars, looking less like a holiday resort and more like a high-tech settlement on a distant planet. Aryan stared at the rows of glowing amber tents, their lights, distorted reflections on the salt crust below.

He couldn't help but feel he was entering a moon base. "How do you build a city on a dried-up ocean?" he asked, the silence of the Rann pressing against the windows. Dr. Sarabhai, his mentor, looked out at the glowing vast city. "You don't just build it, Aryan. You engineer it to coexist with history." To understand the city, they first had to understand the "history" beneath it. They pulled over at the edge of the salt, just off the famous "Road Through Heaven". The air was sharp, dry, and carried a cold wave that instantly pulled the moisture from their skin. Dr. Sarabhai kicked a chunk of the hard white crust. "Millions of years ago, you would be underwater right now, Aryan. This was once a thriving, shallow part of the Arabian Sea." He pointed to a distant ridge. "But the earth is restless. Massive Tectonic Uplift (the upward movement of the Earth's crust caused by shifting plates) raised this entire landmass, effectively trapping a portion of the sea here." He knelt and picked up a crystal. "Over centuries, the fierce sun boiled the water away. What you're walking on isn't sand, it's the remains of that ancient ocean.

It's a 'Trapped Sea'. The salt is mostly Halite (common rock salt, here; white salt) and Gypsum, minerals left behind as the water evaporated." Aryan looked at the crystals, fascinated. "So the Rann Utsav is a celebration on a dried-up seabed?" "Exactly," Dr. Sarabhai nodded. "Every monsoon, the sea and nearby rivers rush back in to reclaim this land, flooding the vast basin. We can build this city in winters only because of the laws of thermodynamics (the physics of heat energy and transfer). The intense solar heat drives a high rate of evaporation. This triggers Capillary Action, a process where the brine solution (extremely salty water) from beneath the earth is pulled upward to the surface. As that water vanishes into the dry air, it leaves behind billions of interlocking salt crystals that make this ground solid and stable enough to support us.

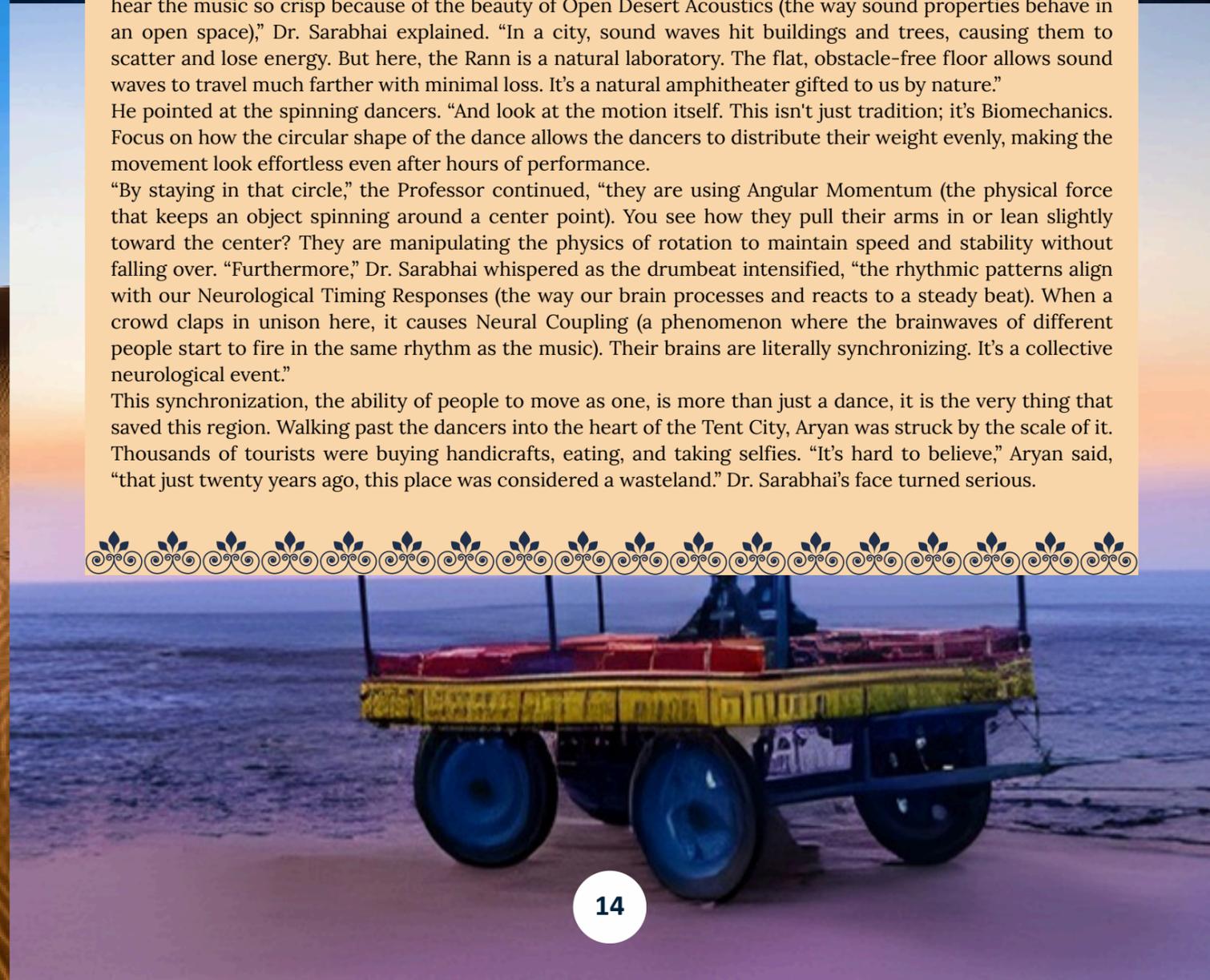


We aren't just celebrating, Aryan, we are dancing on a temporary timeline strictly dictated by the sun." As the ancient geology of the Rann sets the stage, the people of Kutch provide the rhythm. As they walked closer to the festival grounds, a mix of folk music and dance began to fill the air. A group of dancers in vibrant, mirrored skirts were performing in a perfect, swirling circle. "The music sounds so crisp," Aryan noted. "Even from this distance, I can hear the subtle strike of the sticks and the resonance of the drums." "No Aryan, you hear the music so crisp because of the beauty of Open Desert Acoustics (the way sound properties behave in an open space)," Dr. Sarabhai explained. "In a city, sound waves hit buildings and trees, causing them to scatter and lose energy. But here, the Rann is a natural laboratory. The flat, obstacle-free floor allows sound waves to travel much farther with minimal loss. It's a natural amphitheater gifted to us by nature."

He pointed at the spinning dancers. "And look at the motion itself. This isn't just tradition; it's Biomechanics. Focus on how the circular shape of the dance allows the dancers to distribute their weight evenly, making the movement look effortless even after hours of performance.

"By staying in that circle," the Professor continued, "they are using Angular Momentum (the physical force that keeps an object spinning around a center point). You see how they pull their arms in or lean slightly toward the center? They are manipulating the physics of rotation to maintain speed and stability without falling over. "Furthermore," Dr. Sarabhai whispered as the drumbeat intensified, "the rhythmic patterns align with our Neurological Timing Responses (the way our brain processes and reacts to a steady beat). When a crowd claps in unison here, it causes Neural Coupling (a phenomenon where the brainwaves of different people start to fire in the same rhythm as the music). Their brains are literally synchronizing. It's a collective neurological event."

This synchronization, the ability of people to move as one, is more than just a dance, it is the very thing that saved this region. Walking past the dancers into the heart of the Tent City, Aryan was struck by the scale of it. Thousands of tourists were buying handicrafts, eating, and taking selfies. "It's hard to believe," Aryan said, "that just twenty years ago, this place was considered a wasteland." Dr. Sarabhai's face turned serious.



“It was worse than a wasteland, Aryan. After the 2001 Earthquake, Kutch was broken. Villages were flattened. The economy collapsed.” He swept his hand towards the tents. “This festival was born out of Crisis Management. The leadership looked at the disaster, the endless, salty nothingness, and decided to turn their biggest liability into their biggest asset. This wasn't just for tourism, it was an economic engine to save a region. And it worked, Dhordo was just named the ‘Best Tourism Village 2023’ by the UNWTO (United Nations World Tourism Organization).”

But transforming a disaster - hit salt marsh into a world-class destination required more than just a vision, it required an engineering miracle. They wandered toward the residential zone, where row upon row of tents stood rigid against the fierce desert winds. “Building here is a civil engineering challenge,” Dr. Sarabhai noted. “The ground is highly corrosive because of the salt, and the wind speeds can be unpredictable. That is why this city utilizes Modular Structural Design i.e. Everything is made for quick assembly and dismantling.” He tapped a tent pole. “They use raised flooring to protect against ground moisture and salt. And look at the guests, they are all reaching for shawls as the sun dips.

This is Thermodynamics in its rawest form. Because salt and dry soil have incredibly low Heat Retention (the ability of a material to store heat), the Rann experiences extreme temperature variations. In winter, it stays between 12°C and 25°C. As soon as the sun vanishes, that heat is lost rapidly to the atmosphere. The local Kutchi clothing, thick fabrics for insulation and loose designs for airflow, was actually engineered for this specific cycle centuries ago.” Aryan adjusted his jacket as the cold intensified, realizing that every layer of the festival was designed to protect life from the elements. “So the timing really is everything?”

“Precisely. This is the Winter Timing of the Rann Utsav,” Dr. Sarabhai said. “The salt crust is only stable after the monsoon evaporation is complete, and the winter temperatures are actually survivable for us. But it is also about protecting what we cannot see. Look up.” The sky was a riot of stars. The Milky Way looked like a thick brushstroke of diamond dust across a black canvas.

“To protect this view, we use Shielded Lighting (light fixtures that point strictly downward to reduce glare),” the Professor whispered. “Thousands of migratory birds, like flamingos, eagles, and cranes, pass through these wetlands”. “They migrate at night and use the moon and stars to navigate as it is their internal GPS. If the Rann Utsav used bright, upward-facing lights, the birds would get confused and drawn into the glare and circle endlessly until they drop from exhaustion. By using warm, shielded lights, we aren't just saving the view for tourists, we are saving the lives of the wildlife that lives in the dark.”

As they walked back toward the camp, Aryan didn't see a “barren wasteland” anymore. He saw a living, breathing laboratory. He saw the Geology of a trapped ocean beneath his boots, the Acoustics in the desert air, and the Engineering that allowed a city to exist where it shouldn't. “You know, Professor,” Aryan said, “I thought Rann Utsav was just about camels and culture. But it's actually a celebration of human adaptation and scientific resilience.” Dr. Sarabhai smiled, looking back at the glowing amber tents of Dhordo. “That is the real secret of the Rann, Aryan. In a place where nothing is supposed to grow, the people of Kutch found a way to make a miracle out of salt. In this desert, survival isn't just a fact; it's the greatest celebration on Earth.” As the music of the Rann faded into the night, Aryan realized that every tradition he had witnessed was anchored in a law of nature. To help other travelers see the desert through the eyes of a scientist, he began to jot down a summary of the invisible forces that make the Rann Utsav possible.

The Mystery	The Scientific Reality	Why it Matters
Traveling Sound	Open Desert Acoustics	Lack of obstructions allows sound waves to travel farther with minimal loss.
Clear Night Sky	Atmospheric Transparency	Shielded Lighting preserves the "Dark Sky" for humans and birds.
Earthquake Resilience	Engineering	Traditional Bhungas (circular mud huts) distribute stress, preventing collapse.
Winter Timing	Thermodynamics	Salt crust is only stable after monsoon evaporation, temperatures are survivable (12 - 25°C).
Economic Growth	Crisis Management	Rebranding a disaster-hit region into a UNWTO-awarded global destination.



# The Science Behind Tradition

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The tradition of celebrating festivals is a priceless gift passed down to us by our ancestors. Every festival we celebrate is deeply rooted in religious values, cultural wisdom, and scientific understanding. Festivals of Gujarat, in particular, promote unity, self-discipline, spiritual growth, and collective joy. They are a harmonious blend of tradition, culture, music, dance, crafts, and vibrant energy that brings people together and creates unforgettable experiences.

But have you ever wondered whether there is science behind these celebrations? Beyond religious beliefs, each festival carries practical reasoning connected to nature, climate, and human well-being. Gujarat celebrates numerous festivals such as Navaratri, Diwali, Holi, Ganesh Chaturthi, and many more, all of which are thoughtfully aligned with seasonal and environmental changes. Diwali is one of the grandest festivals celebrated across Gujarat. On Diwali, people worship Lord Dhanvantari, the deity associated with health and well-being. This emphasis on health is not accidental. In the Northern Hemisphere, from the Trayodashi of the Kartika month, the position of the Earth relative to the Sun begins to change. As winter approaches, life processes naturally slow down. Animals such as bears hibernate, seeds sprout slowly, and overall biological activity reduces. These natural changes indicate a seasonal slowdown in life.

Our ancestors understood this phenomenon and designed Diwali as a method to help humans transition into winter without falling ill, feeling depressed, or losing balance. During winter, the Northern Hemisphere tilts away from the Sun, resulting in reduced sunlight and lower temperatures. Hence, early morning sun exposure becomes essential. Diwali celebrations encourage people to wake early, stay active, and spend time outdoors, thereby increasing sun exposure. Lighting diyas plays a significant role as well. The light from oil lamps interacts with the surrounding magnetic field and generates electromagnetic waves that activate blood cells and enhance immunity. Additionally, winter humidity promotes the growth of insects such as mosquitoes. The use of lamps and firecrackers helped ward off insects and purify the surroundings. Diwali sweets prepared with ghee provide warmth, energy, and improved digestion during cold months. Moreover, collective celebrations, laughter, and joy act as psychological stress relievers. Holi adds vibrant colors to Gujarat's cultural canvas and offers a fascinating blend of chemistry and seasonal therapy. Traditionally, natural colors made from turmeric, marigold, rose petals, beetroot, and neem were used. These substances possess medicinal properties beneficial for skin care and immunity. Holi coincides with seasonal transition, making it a form of natural therapy for the body.



The bonfire of Holika Dahan symbolizes purification. Burning medicinal herbs releases smoke that helps cleanse the air and supports respiratory health. Consuming foods like gujiya made from jaggery and dry fruits, along with thandai, boosts digestion and prepares the body for changing seasons. Physical activities during Holi help balance the Kapha dosha accumulated during winter, while sunlight exposure increases vitamin D levels, uplifting mood and reducing stress.

Festivals are not merely celebrations but cultural expressions deeply connected to natural rhythms, climate science, and seasonal timing. Rituals such as fasting were designed to prepare the digestive system for upcoming seasonal diets. Festivals also served as markers for agricultural cycles like planting and harvesting, reflecting a deep bond between human life and nature.

Navaratri is one of Gujarat's most significant festivals, celebrating the divine feminine and symbolizing the triumph of good over evil. It involves nine nights of fasting, prayer, music, and folk dances like Garba. Scientifically, Navaratri occurs during a period when the body becomes vulnerable due to climatic changes. According to ancient traditions, Navaratri is considered a time for resetting both body and mind.

As days become shorter and nights longer during September and October, sleep patterns and metabolism are affected. Navaratri reminds individuals to realign their lifestyle with these changes. Fasting during this time gives rest to the digestive system, which naturally slows down during seasonal transitions. Fasting does not mean starvation but mindful eating. Consuming fruits, milk, curd, dry fruits, and vrat foods made from millets or buckwheat helps detoxify the body, improve gut health, reduce inflammation, and strengthen immunity.

Dance is an integral part of Navaratri. Group dances like Garba release stress and negative energy. Dancing stimulates the release of endorphins, often called "feel-good hormones," which reduce pain, increase happiness, and improve emotional well-being. Our ancestors understood the power of movement and vibration, making dance a spiritual and scientific practice.

Navaratri also emphasizes mental discipline. Waking up early, eating light food, meditating, and praying activate the parasympathetic nervous system, which relaxes the mind, reduces stress, and improves overall mental and physical health.

## Conclusion

Indian festivals are not based on blind belief but are thoughtfully designed systems to help humans live balanced, healthy, and meaningful lives. Science is intricately woven into our traditions. By understanding this scientific foundation, we gain a deeper appreciation of our ancestors' wisdom and their harmony with nature.

Festivals are a fusion of tradition, nature, and scientific insight. Each celebration supports lifestyle balance, emotional stability, immunity, and social harmony. Diwali prepares the body and mind for winter, Holi releases emotional stress and enhances social bonding, and Navaratri strengthens immunity, discipline, and mental peace.

The science behind festivals was meant not only for worship but also for educating society. Through celebration, Indian festivals pass on lessons of balance, discipline, and well-being, making science accessible to everyone.

# Ganesh Visarjan: A Time When Nature and Tradition Walked Together

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## A Tale of Sustainability, Science, and Belief

Little Reeva looked forward to Ganesh Chaturthi every year. She was delighted to see the little statue of Lord Ganesha on the wooden platform in her house, as mentioned in **Image 1**. She cherished the sound of religious melodies, the sparkle of candles, and the scent of fresh flowers. But she was constantly disturbed by one question. One evening, she whispered, "Papa, where would Bappa go after Visarjan?" Her dad hesitated. He was aware that an answer was not straightforward. But things were different that particular year. A Pivotal Moment; The environmentally conscious Ganesh Visarjan was mentioned by Reeva's teacher. She described how traditional idols constructed of plaster of Paris (POP) seriously damage water bodies and are difficult to disintegrate as depicted in **Image 2**. The main component of POP is calcium sulfate hemihydrate, a substance that affects aquatic life by settling in sediments and raising water turbidity (Central Pollution Control Board, India). Plants suffocate, fish perish, and water becomes dangerous. After Anaya told her family about this, they made the decision to bring an environmentally friendly clay Ganesha statue home that night. An alternative to this harmful material is clay, which is biodegradable and environmentally friendly.

## The Science Behind the Choice

Shadu mitti, or natural river clay, as showcased in **Image 3**, is used to create natural clay idols. This clay does not produce any harmful leftovers and dissolves readily in water. Environmental studies show that immersion of natural clay has little effect on water pH, dissolved oxygen (DO), and biochemical oxygen demand (BOD), three important water quality indicators (CPCB, 2020). On the other hand, heavy elements like lead, mercury, and chromium are present in the synthetic paints used on POP idols. Fish and, eventually, human health are impacted by these metals as they bioaccumulate along the food chain (WHO, 2017). As her father described this science, Reeva paid close attention. Faith and facts walked together for the first time. Honouring with Accountability Instead of utilizing plastic embellishments, the family used flowers, turmeric, and vermilion to adorn the idol. On the day of Visarjan, they opted for home immersion in a pail of water rather than visiting a river. A fundamental idea of sustainable environmental management, waste reduction is a scientific premise that this approach adheres to. After dissolving, the clay water was added to their garden soil, which improved its texture by increasing the soil's porosity and mineral content. The comparison of effect of POP idol and the Clay idol has been depicted in **Table 1**. Reeva silently observed the idol's gradual disintegration as depicted in **Image 4**. She said, "Bappa is not going." "He is assimilating into our planet." The circular economy idea, which reintegrates waste items into natural cycles rather than discarding them, is reflected in the eco-friendly Ganesh Visarjan (UNEP, 2019).

We should utilize clay to safeguard our environment since, as we can see from the comparison, it is considerably superior to POP. According to the Brundtland Report (1987), these actions support environmental sustainability, which is defined as satisfying current needs without endangering ecosystems in the future.

## Community Change Begins Small

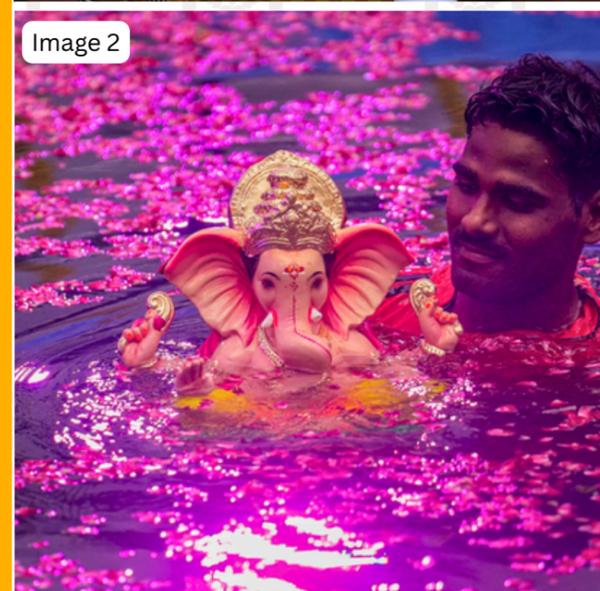
The next year, neighbours joined them, motivated by Reeva's family. Children learned how to create Ganesh idols using clay in a nearby workshop, which is exhibited in **Image 5**. Following the clay idol's dissolution, the clay was released into a pot for usage, as these seedlings sprouted after Visarjan, signifying renewal. This strategy is in line with green innovation, which uses ecological knowledge to create cultural behaviours. Collective eco-friendly Visarjan can minimize festival-related water pollution in urban lakes by almost 60%, according to scientific assessments (IIT Bombay Environmental Monitoring Report, 2021). Take-home message Ganesh is worshipped as the remover of obstacles. One of the biggest challenges facing humanity today is environmental deterioration. Devotees respect both tradition and ecological principles by selecting environmentally appropriate Visarjan. In her notepad, Reeva wrote: "Life is protected by true devotion."

## In conclusion

Eco-friendly Ganesh Visarjan is a scientific advancement rather than a rejection of tradition. It illustrates the healthy coexistence of faith, culture, and ecology. Rivers, soil, and biodiversity may be protected for future generations by small household decisions that are informed by scientific knowledge. Festivals become celebrations of life itself when customs work in harmony with nature rather than against it.

Table 1

Parameter	POP Idol	Natural Clay Idol
Dissolution time	Several months	Few hours to days
Heavy metal release	High	Negligible
Impact on aquatic life	Severe	Minimal
Soil reusability	Not suitable	Suitable



# Natural Pigments in Navratri and Holi

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## Introduction:

Indian festivals represent a harmonious blend of culture, tradition, spirituality, and science. Among them, Navratri and Holi stand out as celebrations where colours play a central symbolic and aesthetic role. Traditionally, these colours were not artificial powders but were derived from natural sources such as flowers, leaves, roots, seeds, and minerals. With the advancement of industrial chemistry, synthetic dyes gradually replaced natural colours due to their low cost and bright appearance. However, scientific research has revealed that many synthetic dyes contain toxic chemicals that pose risks to human health and the environment. In recent years, there has been a renewed interest in natural colours due to growing awareness of green chemistry, sustainability, and health safety. This article explores the chemistry behind natural colours used during Navratri and Holi, supported by research based scientific concepts, and presents the topic in a manner suitable for undergraduate college students.

## Historical Background of Natural Festival Colours:

In ancient India, festival colours were prepared using locally available natural resources. Flowers like palash (*Butea monosperma*), hibiscus, and marigold were dried and powdered, while turmeric, sandalwood, and indigo were used extensively. These practices were not accidental; they reflected empirical knowledge of natural pigments and their safe interaction with human skin. Gujarat, known for its vibrant Garba and Navratri celebrations, traditionally emphasized purity and harmony with nature. The use of herbal colours during festivals aligned with Ayurvedic principles, which promoted substances that were beneficial or at least non-harmful to the body.

## Natural Sources of Traditional Festival Colours:

Natural colors originate from biological and mineral sources containing specific chemical compounds known as chromophores, which absorb certain wavelengths of light and reflect others.

## Common natural sources include:

- Turmeric rhizome (*Curcuma longa*) – yellow colour
- Hibiscus *rosa-sinensis*, palash, and rose petals – red to orange shades
- Neem, spinach, coriander, and henna leaves – green colour
- *Indigofera tinctoria* (indigo plant) – blue colour
- Sandalwood and saffron – pale yellow to orange hues
- These materials are renewable, biodegradable, and easily decomposed in the environment. Chemistry of Natural pigments

## 1. Curcumin – The Yellow Pigment of Turmeric

Curcumin is the principal bioactive pigment found in turmeric. Chemically, it is a polyphenolic diarylheptanoid compound. Its molecular structure allows it to absorb blue light in the visible spectrum (around 420–430 nm), reflecting yellow light. Curcumin exhibits keto–enol tautomerism, a concept taught in organic chemistry, which explains its stability and colour variation under different pH conditions. In alkaline conditions, curcumin shows a reddish-brown colour, demonstrating acid–base chemistry principles. Research published by CSIR and other scientific institutions highlights curcumin's antioxidant, anti-inflammatory, antimicrobial, and antifungal properties. These properties explain why turmeric-based colours were traditionally considered safe for skin application during festivals.

## 2. Anthocyanins – pH-Sensitive Natural Pigments

Anthocyanins are water-soluble pigments belonging to the flavonoid group. They are commonly found in hibiscus flowers, berries, grapes, and pomegranate peels. Chemically, anthocyanins exist as glycosides of anthocyanidins. A key scientific property of anthocyanins is their pH-dependent structural transformation: Acidic medium → red colouration, Neutral medium → purple colouration, Alkaline medium → blue colouration. Because of this behavior, anthocyanins are studied as natural pH indicators in analytical chemistry. Their non-toxic nature makes them suitable for use in festival colours and educational laboratory demonstrations.

## 3. Chlorophyll – The Green Pigment

Chlorophyll is a porphyrin-based pigment with a central magnesium ion. It plays a vital role in photosynthesis by absorbing red and blue wavelengths of light while reflecting green light. From a chemical perspective, chlorophyll demonstrates coordination chemistry due to the presence of a metal ion within an organic ring structure. When used as a natural colour extracted from leaves, chlorophyll is biodegradable and does not cause skin irritation. The presence of chlorophyll-rich leaves during Navratri decorations symbolically represents growth, renewal, and energy, aligning scientific function with cultural meaning.

## 4. Indigo – A Natural Blue Dye and Redox Chemistry

Indigo dye is obtained from the plant *Indigofera tinctoria*. The colour-producing compound, indigotin, is formed through enzymatic hydrolysis of indican followed by oxidation in air. This process is a classic example of oxidation–reduction (redox) reactions, a fundamental topic in physical chemistry. Traditional indigo dyeing techniques demonstrate applied chemistry long before modern laboratories existed.

## Health and Safety Aspects of Natural Colours ;

Scientific studies by the World Health Organization (WHO) and environmental agencies have reported that many synthetic dyes used in commercial Holi colours contain harmful substances such as: Lead salts, Chromium compounds, Mercury-based pigments. These chemicals can cause skin allergies, eye irritation, respiratory problems, and long-term toxicity. In contrast, natural pigments have biocompatible molecular structures and are easily metabolized or washed away without penetrating the skin barrier. Ayurvedic literature also supports the use of turmeric, neem, and sandalwood due to their antimicrobial and cooling properties, making them suitable for mass celebrations.



The use of natural colours strongly supports the principles of green chemistry, which include: Use of renewable raw materials, Reduction of toxic chemicals, Biodegradability, Minimal environmental pollution. After Holi celebrations, synthetic colours often contaminate soil and water bodies, affecting aquatic life. Natural colours, however, undergo microbial degradation and do not persist in the ecosystem. Environmental science research emphasizes that adopting natural festival colours can significantly reduce chemical waste generation during large public celebrations. Natural pigments used in festivals are now extensively studied for modern applications:

- Food industry – natural food colourants
- Cosmetics – herbal dyes and skin-friendly products
- Pharmaceuticals – antioxidant and therapeutic agents
- Textile industry – eco-friendly dyeing processes

Thus, traditional knowledge has continuously inspired modern scientific innovation. Many cultural practices are firmly supported by scientific logic. For instance, the use of turmeric during Navratri is not merely ritualistic; its well-established antimicrobial and anti-inflammatory properties scientifically justify its role in purification rituals. Similarly, neem-based green colours traditionally used in certain regions offer natural protection against infections due to their medicinal qualities. These examples demonstrate that cultural practices were not arbitrary but were intuitively guided by scientific understanding long before modern science formally explained them.

**Conclusion:**

The chemistry of natural colours used during Navratri and Holi reflects India's deep-rooted scientific heritage. Ancient practices of using plant-based pigments align remarkably well with modern concepts of green chemistry, health safety, and environmental sustainability. Reviving the use of natural colours not only preserves cultural authenticity but also promotes scientific awareness and responsible celebration. These festivals beautifully demonstrate that tradition and science are not separate domains but interconnected aspects of human knowledge.



# The Biology of Group Dancing: How Garba Improves Brain and Body Health

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As the dhol begins its rhythmic pulse on the first night of Navratri, thousands gather in circles across Gujarat. For nine consecutive nights, people dance Garba for hours—not just celebrating, but engaging in one of the most scientifically remarkable activities that simultaneously enhances physical health, brain chemistry, and social bonds. What appears as simple folk dance is actually a biological masterpiece.

## The Cardiovascular Symphony:

Garba is classified as moderate to vigorous aerobic exercise, with heart rates reaching 60-85% of maximum capacity—the optimal zone for cardiovascular conditioning. During slower songs, heart rate stabilizes around 120-130 beats per minute. When tempo increases during fast dandiya raas, it spikes to 150-170 bpm. This interval training pattern is precisely what exercise physiologists recommend for heart health.

Over nine nights, this repeated cardiovascular workout increases stroke volume (blood pumped per heartbeat) and decreases resting heart rate—both indicators of improved heart health. As dancers move continuously, blood vessels dilate through vasodilation, where the endothelium releases nitric oxide that relaxes vessel walls, improving circulation and reducing blood pressure by 5-10 mmHg with regular participation.

## Neurochemistry: The Brain's Natural High:

The most remarkable aspect of Garba is its effect on brain chemistry, creating what scientists call the "dancer's high" through a cascade of neurochemicals. Endorphins, nature's painkillers produced in the pituitary gland, increase by 200-500% during intense Garba sessions. These endogenous opioids bind to brain receptors, producing euphoria and pain reduction—explaining why dancers feel energized despite hours of exertion. Dopamine, the pleasure neurotransmitter, floods the brain as rhythmic movements activate the basal ganglia. Successfully synchronizing with music and others triggers the brain's reward system, creating positive reinforcement that makes stopping difficult. The social coordination amplifies this effect, creating powerful neurochemical incentive for continued dancing. Serotonin, the mood regulator, increases during aerobic exercise. Regular Garba participation elevates baseline serotonin levels, explaining improved mood and reduced anxiety during Navratri.

## Biomechanics: Coordinated Motion:

Garba movements engage nearly every major muscle group through sophisticated biomechanical coordination. The signature circular movement creates constant rotation, requiring the vestibular system in the inner ear to maintain balance. Regular practice enhances vestibular function and proprioception—the body's spatial awareness—reducing fall risk and improving coordination. Lower body muscles (quadriceps, hamstrings, calves, gluteals) work continuously during stepping patterns. The squat-like movements particularly strengthen legs and improve power. Core muscles stabilize the trunk during turns, developing strength crucial for spinal health. Upper body movements in dandiya raas improve shoulder strength and hand-eye coordination. The multi-directional movements promote joint health by circulating synovial fluid that lubricates joints. Unlike high-impact running, Garba's circular patterns distribute forces evenly across joint surfaces, maintaining cartilage health while increasing range of motion—making it suitable for all ages.

## Respiratory and Metabolic Benefits:

Sustained dancing increases respiratory rate from 12-16 breaths per minute at rest to 30-40 during vigorous movement. This strengthens the diaphragm and intercostal muscles, improving lung capacity over time. Garba uses aerobic metabolism, where muscles consume glucose and fatty acids with oxygen to produce ATP (cellular energy). This improves mitochondrial density in muscle cells—more mitochondria mean more efficient energy production, explaining why regular participants develop better endurance. A 150-pound person burns approximately 250-400 calories per hour during moderate Garba, and 400-600 during vigorous dancing. Over a typical 3-hour session, this translates to 900-1500 calories burned. Across nine Navratri nights, participants expend approximately 10,800 calories—equivalent to losing 1.5 kilograms of fat. Regular aerobic activity also improves insulin sensitivity, reducing diabetes risk and maintaining stable blood sugar. Muscle contractions activate glucose transporters, allowing glucose uptake without insulin, providing immediate blood sugar regulation.

## Cognitive Enhancement:

Garba provides a comprehensive cognitive workout that may protect against age-related decline. Learning and remembering steps stimulates neuroplasticity—the brain's ability to form new neural connections. The hippocampus activates during memory formation, while the cerebellum coordinates movement. Research shows regular dancing improves memory, spatial awareness, and processing speed. Continuous decision-making during Garba—adjusting speed, navigating crowds, anticipating movements, matching rhythms—engages the prefrontal cortex responsible for executive functions like planning and impulse control. The combination of physical activity, music, and social connection creates powerful stress reduction. Cortisol (the stress hormone) levels drop while happiness hormones increase, counteracting chronic stress that contributes to anxiety, depression, and immune suppression.

## Social Biology of Synchronized Movement:

Mirror neurons fire both when we perform actions and when we observe others performing them. During Garba, as dancers watch and mimic each other, mirror neuron systems activate throughout the group, creating neural synchronization that enhances empathy and social understanding.



From evolutionary perspective, synchronized group movement promoted social cohesion, trust, and cooperation crucial for survival. Modern Garba activates these ancient neural circuits, creating bonding effects at the neurological level—not just psychological but biological.

The circular formation is particularly significant. Circles are egalitarian with no hierarchical leader. Everyone sees everyone, promoting equal participation and maximizing facial visibility for reading emotions, further enhancing social bonding.

#### Age-Appropriate for All Generations

Garba's accessibility across age groups makes it uniquely valuable. For children, it develops fundamental movement skills: balance, coordination, rhythm, and spatial awareness, while teaching cooperation and cultural participation. For adults, it provides cardiovascular exercise without high-impact joint stress, with social motivation maintaining consistency. For elderly participants, balance challenges improve stability reducing fall risk, cognitive engagement maintains mental sharpness, and social interaction combats isolation and depression. The adaptable intensity allows everyone to move at comfortable speeds while gaining cardiovascular and social benefits. Many elderly Garba enthusiasts report better mobility, balance, and overall well-being compared to non-dancing peers.

#### Sustainability: Zero-Carbon Celebration

From a scientific sustainability perspective, Garba represents an ideal celebration model. It requires no electricity-consuming equipment, produces no waste, and uses only human energy—a completely renewable resource. The energy powering Garba comes from ATP produced by metabolizing food. Dancers convert plant-based nutrients into mechanical energy with zero carbon emissions. The circular, communal nature requires no stage construction, elaborate decorations, or resource-intensive infrastructure. The environmental footprint is minimal—just people, music, and open space—demonstrating that the most sustainable celebrations harness human energy and social connection rather than technology and consumption.

#### Conclusion:

Garba is a biological masterpiece that simultaneously optimizes cardiovascular health, neurochemistry, musculoskeletal function, cognitive performance, and social bonding. Every twirl activates the vestibular system, every step strengthens muscles, every synchronized movement releases bonding hormones, and every shared smile reduces stress hormones.

The nine nights of Navratri provide concentrated health benefits that modern medicine struggles to replicate with pills and procedures. As Gujarat celebrates, participants engage in one of the most effective health interventions available, wrapped in cultural tradition and social joy.

Science reveals what our ancestors intuitively understood: movement, music, and community are fundamental to human health and happiness. The next time you join a Garba circle, remember—your heart is strengthening, your brain is releasing happiness molecules, your muscles are coordinating in complex patterns, and your social bonds are deepening through neurochemical magic. You're not just dancing; you're participating in a biological symphony that makes you healthier, happier, and more connected. That's the true science behind Gujarat's festive spirit.



# The Science Behind Gujarat's Festive Spirit

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## Introduction: Festivals Where Culture Meets Science

The festivals of Gujarat essentially signal the celebration of tradition and faith, ingrained in scientific understanding at the root of day-to-day life. Among those, Navratri and Holi have been two outstanding festivals, famous for their use of colors, energy, and enthusiasm. While people very commonly associate these celebrations with joy, dancing, and social bonding, few actually think that behind this festive spirit lies a strong foundation of chemistry. The colors used during these festivals are not mere random acts of decoration but, rather, are results of chemical compounds interacting with light, skin, fabrics, and the environment. Once understood, this science will help us appreciate how closely ancient traditions were actually linked to nature and sustainability.

## Colors Play an Important Part in Gujarat's Festival Tradition:

Colors play a powerful role in human emotions and behavior. Scientifically, colors stimulate the brain and influence mood, energy levels, and mental well-being. The bright colors of red, yellow, blue, and green have been known to promote joy, enthusiasm, and positivity. That is the reason all the festivals in Gujarat are colored with such vivid colors that match the zealous spirit of the people. Traditionally, these colors were obtained from flowers, leaves, roots, and spices. The natural colors derived from these elements were safe and also had biodegradable and skin-friendly properties; it goes to show how cultural practices were allied with environmental and human health much before science in the modern world explained their benefits.

## The Chemistry of Natural Colors in Holi:

Holi, being the festival of colors, happens to be the real example of chemistry through celebration. Earlier, the colors for Holi were prepared from plant-based materials, each containing particular organic compounds which gave them their color. The red color was obtained from Palash flowers (*Butea monosperma*). Anthocyanins are responsible for the orange-red color of the flowers. The anthocyanins absorb certain wavelengths of visible light and reflect red and orange shades, thus giving the bright color to the flowers. The yellow color was derived from turmeric. The compound curcumin is responsible for providing a strong yellow pigment in turmeric. Curcumin, however, is also famous for its antibacterial and anti-inflammatory traits, which makes it suitable and safe for skin contact.

Green colors were extracted from leaves like spinach, coriander, and neem. The green color in these leaves is due to chlorophyll, the pigment responsible for photosynthesis in plants. Chlorophyll reflects green light, accounting for the natural color of plants. Blue color was conventionally prepared from the plant indigo (*Indigofera tinctoria*): the indican chemical present in the leaves oxidizes to form indigo dye. Well, all this is a perfect example of natural chemical reactions put to great use in day-to-day life. All these combined colors made Holi not only joyous but also eco-friendly.

## Colour Chemistry in Navratri Celebrations

Navratri celebrations in Gujarat are renowned for Garba and Dandiya, where people wear spectacularly colored traditional outfits. Traditionally, such fabrics were colored by natural dyes derived from plants and minerals. The shades of red and pink come from the madder root due to a natural dye present in it called alizarin, which forms very stable bonds with cotton and silk fibers. Yellow dyes were extracted from turmeric and marigold flowers. Blue shades were created using indigo dye. Green fabrics were prepared by mixing yellow and blue natural dyes.

Textile dyeing is essentially the chemistry of interactions between the dye molecules and fabric fibers through hydrogen bonding, weak intermolecular forces, which help the dye stay affixed to the fabric but not at the cost of harmful or injurious skin irritations for long-lasting color. This shows how traditional textile practices were scientifically efficient and viable.

## Scientific Benefits of Using Natural Colors:

Natural colors have several advantages over synthetic colors. They are nontoxic and free from harmful heavy metals or industrial chemicals. As they biodegrade, they do not pollute the soil or water bodies once used. The natural pigments are less reactive with skin proteins and hence have fewer chances to cause allergies or skin irritation. In contrast, many synthetic colors being used today could cause health problems and environmental destruction. Modern science now confirms what traditional wisdom had already tried for centuries—that natural materials are much safer and more viable.

## Traditional Knowledge Supported by Modern Science

Ancient Indian traditions were related to observation and experience. The use of plant-based colors during festivals was not only symbolic but practical, too. Nowadays, scientific investigations confirm the medicinal and environmental benefits of natural pigments. That means cultural practices were based on an understanding of natural chemistry, even without formal scientific terminology. Reviving these traditions will not only reduce pollution but also help in sustaining cultural identity.

## Conclusion

Celebrating Festivals with Scientific Awareness The festive spree of Gujarat has also evolved as the most beautiful amalgamation of culture, delight, and science. The chemistry behind this preparation of natural colors in Navratri and Holi reveals how traditional celebrations were designed with respect to nature. It invokes responsible celebration and respect for the environment. By reverting to natural colors, Gujarat's festivals can be vibrant, safe, and long lasting for the coming generations. When science is added to tradition, celebrations turn out not only joyous but also sustainable.

# Ayurvedic Science Behind Fasting During Festivals

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## Introduction:

Fasting during festivals has always had a traditional value in India. It has religious and geographical diversity. As many people believe, fasting has a common practice all across the world, which has a notion of pleasing the deities and lessening the hearts. Ayurveda, the science of life, stands exceptional because it has a rich scientific justification behind the stigma of practice. As Ayurveda defines, fasting has a profound effect because, according to the theory, fasting assists in balancing the body, heart, and the environment. Proper fasting has the ability to clean the body, develop digestion, and sharpen the mind.

## Ayurveda and the Concept of Digestive Fire (Agni):

Agni, also known as the digestive fire, is the key to good health, according to the principles of Ayurvedic medicine. The existence of a positive Agni ensures the smooth digestion and absorption of food, and a poor Agni is responsible for the generation of Ama, which is a toxic by-product of indigestion.

The fast food that is served during a festival may include light foods, fruits, milk, or simply abstaining from all foods for a brief period of time. The result is that it gives the digestive system a rest, allowing Agni to regain strength. The body, freed from processing food, automatically eliminates all the poisons that it has been loading up.

## Seasonal Alignment and Fasting:

Most Indian festivals are also known to be closely associated with changes in the seasons. It is believed in Ayurveda that at the time of Ritu Sandhi, one is most likely to face imbalance in Vata, Pitta, and Kapha Doshas. Fasting or eating light food during this period helps in a smooth transition of the body to the changes in the environment.

For instance:

- Navratri fasting can also provide the benefit of detoxification.
- Ekadashi fasting helps in the reduction of Kapha and purifying the intestines.
- Shravan Month fasting can help in lessening the 'excess heat' that prevails in the human body, thus making the metabolic rates regular.
- Hence, the tradition of fasting observed during the festivals acts as a natural preventive measure for good health.

## Detoxification and Cellular Rest:

Modern science confirms that Ayurvedic practices the idea of short-term fasting as an accelerator of autophagy – the removal of damaged body cells replaced by brand-new ones. This idea is shared by Ayurvedic practices: removal of Ama, rejuvenation of tissues Dhatu Shuddhi.

By the avoidance of heavy meals, the energy has been channeled from the digestion aspect to the healing processes of the body. Consequently, the immunity has been boosted, and there is more energy and proper functions of the organs.

## Mental and Spiritual Benefits:

Maintaining the health of the "manas" or "Chitta" or "soul" of the body is given equal importance by Ayurveda, as it is connected with the "manas" or "Chitta," because the health of the "manas" or "Chitta" or "soul" of the body is not alone dependent upon the "manas" or "Chitta. Fasting result in the reduction of the "tamas" of "manas" and "Chitta" and an enhancement of the "sattva

It is this amalgamation of mind and body that explains the interconnection between fasting and spiritual pursuits in Indian culture.

## Importance of Right Method of Fasting:

Ayurvedic practices reject drastic and compelled fasting. "Langhana (Lightening therapy) should be practiced as per the body type, age, health condition, and season," Ayurvedic practices state. "Fruits, milk, herbal fluids, and warm water will provide nourishment and facilitate the process of detoxification," it adds.

Undue fasting can impair Agni rather than increasing its effectiveness. That is why moderation and awareness are important for realizing the true advantages.

## Conclusion:

Fasting during festivals is the finest example that verifies the consonance of ancient wisdom with scientific concepts. According to Ayurvedic wisdom, fasting during festivals represents the holistic remedy for the restoration of digestive health, purifying the body, regulating the doshas, and promoting the improvement of mental well-being. Hangover from religious practices, fasting during the festival represents the long-tested method of preventive healthcare for healthful living in harmony with nature.

In today's fast-paced lifestyle, knowledge of the Ayurvedic science of fasting can enable us to follow this practice with full awareness and respect.

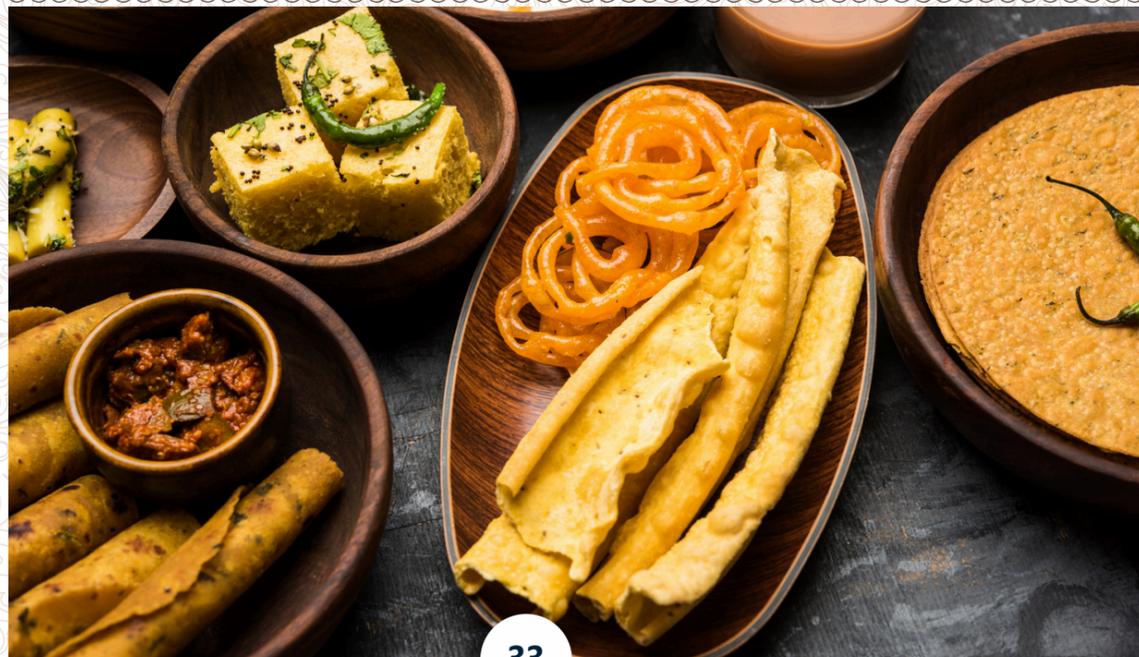
# Festive Flavors, Hidden Formulas: Science Behind Gujarati Traditions

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## “અન્નમબ્રહ્મ” : Sweet Science of Gujarat’s Festive Food

As the Rig Veda reminds us- “અન્નમબ્રહ્મ”, food itself is divine. In Gujarat, this divinity takes the form of festive sweets like fafda, jalebi, mohanthal, laddoo, shrikhand, and ghughra, where culture and chemistry meet on every plate. Each bite is more than taste; it is tradition, memory, and molecular science woven together. Festivals here are not only celebrated with rituals and prayers but also with flavors that carry centuries of wisdom. From the crisp proteins of fafda to the crystallized sugars of jalebi and the caramelized richness of mohanthal, Gujarat’s festive kitchen is a living laboratory where ancient scriptures meet modern science, and sustainability ensures these traditions endure for generations.

“Fafda-Crunch Through Protein Chemistry” is inseparable from Dussehra mornings. The streets of Ahmedabad and Surat fill with stalls serving fafda-jalebi, a ritual that symbolizes victory of good over evil. The science behind fafda lies in chickpea flour proteins. When the dough hits hot oil, proteins unfold and bind with starch, locking into a firm structure. The Maillard reaction, the same process that browns toast, gives fafda its golden color and nutty aroma. Culturally, Fafda is more than food; it is a ritual. Eating fafda after Navratri is almost a social law in Gujarat. Sustainability adds another layer: chickpeas are water-efficient crops, making Fafda not just delicious but also eco-friendly. As the Gujarati proverb says, “અન્નને નંદે, અન્નને પૂજો” which means do not disrespect food, worship it. Fafda embodies this respect, turning humble flour into festive joy.



Jalebi are the spirals of Fermentation and Crystallisation; no festive spread is complete without jalebi. Its bright orange spirals are more than eye candy. They’re chemistry in action. The batter ferments slightly, producing bubbles that puff up when fried, giving jalebi its airy texture. Once fried, it’s dipped in supersaturated sugar syrup, which crystallizes into that sticky glaze we love. The caramel notes come from sugars breaking down at high heat, adding depth to the sweetness. Culturally, jalebi is shared in neighborhoods at dawn during Dussehra, symbolizing community and joy. Sustainability enters when jaggery syrup replaces refined sugar. Jaggery adds minerals, supports local farmers, and reduces the energy needed for sugar processing. Ayurvedic wisdom reminds us: “आहारं महावैषज्यं” meaning food is the greatest medicine. Jalebi may be indulgent, but when made with jaggery, it carries both nutrition and tradition. Mohanthal is the diwali caramelized elegance, often made in big batches to share with neighbors and guests. It begins with besan roasted slowly in ghee, filling the kitchen with a nutty fragrance. These slow roasting triggers caramelization of milk solids and sugars, creating flavors that feel warm and comforting. The texture, grainy yet soft, depends on careful temperature control. Too hot, and it burns; too cool, and it stays raw. Culturally, Mohanthal is a symbol of prosperity, often gifted during Diwali. Sustainability is woven in through locally sourced ghee and milk, supporting rural dairy communities. The Bhagavad Gita reminds us: “युक्ताहारवहारस्य युक्तचेष्टस्य कर्मसु” meaning moderation in food and activity brings balance. Mohanthal, eaten mindfully, is both indulgence and nourishment.

Gujarati festive foods like fafda, jalebi, and mohanthal are living demonstrations of everyday food chemistry. In fafda, protein denaturation of chickpea flour and the Maillard reaction during deep-frying create its crisp texture and nutty aroma. Jalebi, on the other hand, relies on microbial fermentation of the batter to generate carbon dioxide bubbles, which expand during frying, while subsequent immersion in supersaturated syrup leads to sugar crystallization and sticky sweetness. Mohanthal showcases caramelization of milk solids and reducing sugars during slow roasting in ghee, producing complex flavor compounds and a characteristic golden-brown hue. Together, these sweets illustrate how thermal processing, enzymatic activity, and non-enzymatic browning reactions transform simple ingredients into festive delicacies that embody both cultural tradition and molecular science. Indian scriptures repeatedly remind us of food’s sacredness.

The Taittiriya Upanishad says: “अन्नं वनद्यात् तद्व्रतम्” meaning do not disrespect food, this is the vow. In today’s world, this vow translates into sustainability-choosing jaggery over refined sugar, supporting local dairy and farmers, reducing food waste through fermentation, and respecting seasonal crops. Festive sweets thus become lessons in ecological balance. They teach us that indulgence can coexist with responsibility, and that joy can be sustainable. Picture this: Your grandmother roasting besan slowly for mohanthal, telling stories of how her mother did the same during Diwali or your father buying fafda-jalebi at dawn, reminding you that this ritual marks victory of good over evil.

These are not just foods; they are family laboratories, where science is passed down as tradition. Every Gujarati household has its own sweet story. Some families swear by their jalebi’s recipe, others by their mohanthal’s caramelized balance.

These things humanize science, showing that molecules are not abstract but they are lived, tasted, and celebrated. Conclusion Gujarati festive sweets are living examples of how science, culture, and sustainability intertwine. Fafda teaches us about proteins, jalebi about fermentation, mohanthal about caramelization, ghughra about fillings, laddoo about binding, and shrikhand about fermentation.

Together, they remind us that science is not confined to labs, it lives in our kitchens, shaping flavors that define our celebrations. By embracing sustainable practices like jaggery, local dairy, and nutrient-rich fillings, we ensure that these traditions remain timeless, nourishing both our hearts and our planet. As the proverb says: “અન્નને નંદે, અન્નને પૂજો” (as mentioned before). In Gujarat, worship takes the form of sweets, where every molecule is a celebration.

# Garba Genes & Brain Beats: When Gujarat Dances, Science Smiles

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“नादः सवभूतानां जीनम्” (Nādaḥ sarvabhūtānāṃ jīvanam - Sound is the life force of all beings.) This timeless wisdom frames Garba as more than devotion: it is rhythm, resonance, and biology in motion. Introduction Navratri in Gujarat transforms cities into vibrant laboratories of rhythm and devotion. Circles of dancers' orbit around the sacred garbo lamp, symbolizing Maa Ambe's eternal energy. To the devotee, Garba is worship. To the physiologist, it is exercise. To the neuroscientist, it is therapy. And to the sociologist, it is unity. This essay examines Garba as a practice where physics and biology converge with culture, showing how traditional dance improves brain function, strengthens the body, and fosters community resilience.

Garba as Devotion and Physics in Motion The circular formation of Garba is not only a cultural symbol of the cycle of life and seasons but also a living demonstration of circular dynamics. Each dancer's step requires the application of centripetal force to maintain balance within the orbit, while the outward flare of skirts and scarves illustrates centrifugal force in action. The lamp at the center of the circle becomes more than a ritual object; it is a metaphorical sun, radiating energy, with dancers revolving like planets in a cosmic choreography. This imagery reflects harmony between the microcosm of human celebration and the macrocosm of universal motion. The physics of Garba extends beyond movement. Sound waves generated by claps, dhol beats, and rhythmic chants propagate through the crowd, creating resonance that amplifies collective energy. The synchronization of thousands of hands striking together produces constructive interference, intensifying the auditory experience and reinforcing the rhythm. Temple courtyards and open grounds act as natural acoustic chambers, where reflections and reverberations enrich the soundscape, enveloping dancers in a cocoon of vibration. Even the visual spectacle carries scientific meaning. The mirror-work on traditional costumes reflects light in multiple directions, producing dazzling optical effects that enhance the perception of motion. The swirling skirts demonstrate angular momentum, while the coordinated rotations of dancers illustrate principles of rotational symmetry. Thermodynamics plays its part too: the kinetic energy of movement transforms into heat, generating the warmth felt in the crowd. Physics explains these phenomena with equations and principles, yet culture interprets them as devotion. For the dancer, the circle is not merely mechanics but a sacred orbit around divinity. In Garba, the laws of motion and resonance are seamlessly woven into worship, making science and spirituality indistinguishable threads of the same fabric.

Biology of Rhythm and Health Garba is devotion disguised as exercise, a cultural ritual that doubles as a full-body workout. Hours of continuous dancing elevate heart rate, improve lung capacity, and burn calories equivalent to structured aerobic sessions. The repetitive steps strengthen muscles, enhance joint flexibility, and improve postural balance. Dandiya Raas, with its fast reflexive stick movements, sharpens hand-eye coordination and neuromotor skills, making it comparable to agility training. Research confirms that dance improves cardiovascular endurance and reduces risks of metabolic disorders. From a neuroscience perspective, Garba is a biological orchestra. Rhythmic chanting and synchronized clapping calm the amygdala, reducing stress responses.

Dopamine sparks joy, oxytocin deepens social bonds, and endorphins dissolve fatigue - a hormonal triad that explains the euphoria of collective dance. Studies show that group dancing lowers cortisol, the stress hormone, while enhancing resilience and emotional regulation. Brainwave research reveals that rhythmic music stimulates alpha and theta waves, associated with relaxation, creativity, and meditative states. The hippocampus and amygdala centers of memory and emotion are activated by repetitive songs, embedding Garba tunes into long-term memory. Harvard Medical School notes that dance fosters new neural connections in regions responsible for executive function and spatial recognition. This is evidence of neuroplasticity, the brain's ability to rewire itself through repeated rhythmic activity. Beyond the brain, dance influences biomolecular pathways. Reviews of dance therapy highlight measurable changes in hormones and metabolites, including elevated serotonin and oxytocin levels, which contribute to improved mood and social bonding. Such findings support the idea that Garba is not only cultural heritage but also a biological intervention a practice that tunes the brain and body in harmony.

Thus, Garba exemplifies how culture and biology converge. It is devotion expressed through motion, but also a scientifically validated form of therapy: improving cardiovascular health, stimulating neuroplasticity, regulating hormones, and embedding joy into memory. In this way, Garba becomes more than dance - it is a living laboratory of rhythm and health. Cultural Identity and Collective Psychology Garba dissolves barriers in a way few cultural practices can. In the circular formation, distinctions of wealth, age, and social status fade as everyone becomes part of the same rhythm. Rich and poor, young and old, experienced dancers and beginners all join hands metaphorically in a shared orbit around the sacred lamp.

Psychologists describe this phenomenon as collective ritual bonding, where synchronized movement and music create a sense of belonging that transcends individual differences. Scientific studies show that such group activities reduce cortisol, the stress hormone, while increasing oxytocin, the “bonding hormone,” thereby strengthening both emotional resilience and social cohesion. For Gujaratis, this experience is captured in a single word: ekta - unity. The proverb “એકતા માણ ત છે” (In unity, there is strength) reflects not only cultural wisdom but also biological truth. When thousands of dancers move together in harmony, the circle becomes more than a festive ritual; it becomes a living demonstration of how community heals. Science and culture converge here, affirming that togetherness is not just symbolic but physiologically restorative, making Garba both a spiritual practice and a collective therapy.

At Vadodara's United Way Garba, thousands of dancers move like galaxies around the glowing lamp. From above, the scene is physics in motion - circular trajectories, resonance of sound waves, and optics of mirror-work costumes. In Ahmedabad's GMDC Garba, children twirl beside elders, students laugh with strangers, and families dance together. Biology explains the joy: oxytocin flows, cortisol drops, and the brain rewires itself for happiness. Culture explains it as devotion: Maa Ambe unites her children. Conclusion “सांगच्छध्वासां दध्वासां ो मनांसस जानताम्” (Saṅgacchadhvaṃ samvadadhvaṃ sam vo manāṃsi jānatām - Move together, speak together, let your minds be united - Rigveda 10.191.2) This ancient verse captures the essence of Garba: collective rhythm, unity of mind, and devotion expressed through motion. Garba is not only a cultural ritual but also a scientific phenomenon.

Circular formations demonstrate centripetal and centrifugal forces, claps and dhol beats create resonance, and mirror-work costumes scatter light into dazzling optical effects. Thermodynamics explains the warmth of the crowd, while biomechanics accounts for balance and endurance. Biologically, Garba acts as a natural aerobic exercise, strengthening the heart, lungs, and muscles. Neurobiology shows that rhythm stimulates dopamine pathways, oxytocin fosters bonding, and endorphins reduce fatigue - lowering stress and promoting neuroplasticity. Psychologically, Garba embodies collective ritual bonding, dissolving hierarchies and reinforcing belonging. Thus, Garba is more than a festive dance. It is a multidimensional practice - devotion, exercise, therapy, and social unifier. Science calls it mechanics of motion and hormonal regulation. Gujarat calls it Garba. Together, they reveal festivals as medicine for the soul and harmony for society.

# Impact Of Garba On The Garvi Gujarat's Mind & Body

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માટીનું આ કોડિયું ને, મધ્યે મેલ્યો દીવો, ચોપાસ ઘૂમે સખીઓ, માડી જીવે તમારો જીવો

These lines are from a Gujarati couplet (Doha) which literally captures the spiritual meaning behind the Garvi Gujarat's folk dance: Garba Translation: "This body is a lamp made of clay, with the soul as the flame in the center; As friends whirl all around it, it is Your divine life, Mother, that breathes within us." Ras- Garba the term is widely popular in India, especially in Gujarat, the cultural capital of India. It has its significance written in Bhagavad Gita, composed around 8th to 10th century CE. Lord Krishna, along with Gopis, played Raas in a divine circular dance called Mandala (Canto 10, chapter 29-33). The texts also state that even the mere hearing or the witnessing of Raas-Lila faithfully is also a pure form of devotion (Shuddha Bhakti). But wait, aren't Garba and Raas quite different? Even though Raas and Garba share the same roots of Gujarati heritage and symbolism; the literal meaning of garba is quite different. Garba on the other hand is played around a "Garbh Deep" with nine holes in it, which represents the nine gates in our body. Some scholars also believe that it means the nine planets (Navagraha); this metaphorical relation can also correlate to the nine chakras, the energy centers that govern our biological and psychological functions. These metamorphic relations offer a dual perspective: one celestial and one biological. Well, according to interpretations, the clay pot is not the body; it is the light emitting out through the holes. The songs sung during this season cleanse the nine gates of our body. The earthen pot is also called "Garbi" which literally translates into holy womb. The deep, only source of light coming out from those holes is also linked with the "Atma" or the soul. Garba is played in concentric circles around the Garbh Deep, symbolizing the circle of birth, death and rebirth. This continuous change of universe while the divine is still and constant is referred to as "Maya". સોનાનો ગરબો શિરે અંબે મા, રૂપાનો ગરબો માડી રૂપાળો; રત્ન જડિતનો ગરબો માડી, ઝબકે માડી ઝબકે... Translation: "The Golden Garbo is on the head of Mother Ambe, the silver Garbo; Come to play with us, the ground you play on has become beautiful for you." The crescendo of garba starts with slow paced 2-talis slowly increasing the tempo of Dhol to more energetic 3-talis.



The clapping stimulates acupressure points in the palm which are connected to different parts of the body, including heart, lungs, and liver. This is generally done during clapping therapy, improving blood circulation and stimulating the nervous system. Doctors also suggest 30 minutes of clapping everyday. The essence of energetic flow during Garba is precisely made in following Garbo; તાળી પડે તો મારી અંબેમાં રમે, હું તો ઘેર ન જાઉં... Translation: "When the clap of hands begins, I will not go home." These two and three claps are to be synchronized with specific footwork by the dancers while rotating in a circle; it is quite a formidable cognitive task. As this rhythmic dance patterns stimulate the working of cerebellum (small brain), which is responsible for control and balance. The dancers, as a result, have improved proprioception and bilateral coordination of both sides of the brain. The hormones are at spike with the celebratory feeling of Navratri, because even after a full day of fasting, devotees play hours of garba. There's an endorphin rush, as the dopamine increases resulting in more oxygen utilization. The devotees call this attainment of energy a form of energy transfer from Ma Adhyashakti herself, but scientifically it's the hormones at play. This also benefits in achieving the "Flow state", and in the circle the ego, stress and anxieties have vanished. Some psychologists also call the 9-days of Navratri a "Holistic work-out" because dancing garba for an hour burns 400-600 calories and decreases cortisol levels. This directly impact on the hypothalamic-pituitary-adrenal (HPA) axis, shifting the sympathetic nervous system to parasympathetic nervous system, relaxing the body and reducing stress hormones. At the core of Navratri, it is a festive spirit that binds the people together. The sense of social harmony triggers the release of oxytocin, which relaxes the body's nervous system. At some parts of Gujarat people also play Beth Garba and Dandiya, which have more swift movements that use a wide range of muscles in action, like quadriceps, gluteus maximus and core. This increases the metabolic rate of flow of oxygen, increasing glucose efficiency. The "Navratri after glow" is a phenomenon experienced by many participants, as they have reported better quality of sleep afterwards, due to the physical activity, and also a mental peace from the tunes and music of live Garba sung during Garba Nights. Conclusion: As India today walks a tightrope balancing the weight of its cultural richness and modern cutting edge technologies, the Garba still remains relevant. The youth today has a unique level of craze during this season, which can be seen by an increase of 24% to 100% in sales growth in market, according to past year reports. Ultimately it proves that Garba is not just a folk dance but its roots are deeply embedded in our culture and heritage. It must be noted that despite the intuitive energy felt by millions, there's no large scale clinical research done on Garba. The specific energies devotees feel while playing Garba, even after a full day of fasting, are still an untapped research topic. But not everything in this world runs by "clinically done large scale research". Does it? Some things are linked with memories and emotions more, and that's where Navratri lies. On a physical level, The Garba's rhythm and the energetic pace is an excellent cardio workout, improving flexibility and stamina. What's remarkable is its inclusivity - because it is played by all the age groups coming together in the Garbh- Gruh. Nevertheless, the myth of Gujarat's culture shines brighter than any clinical explanation—it's beyond that!

# Use of AI in Crowd Prediction and Event Safety

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Festivals play a major role in shaping the cultural identity of Gujarat. Celebrations such as Navratri Garba nights, religious events, and large community gatherings attract thousands of people at a single location. While these events promote togetherness and cultural pride, they also create significant challenges related to crowd safety, emergency preparedness, and risk control. In recent times, Artificial Intelligence (AI) has appeared as an effective technological solution for predicting crowd behavior and improving safety during large public events. Earlier, crowd management mainly depended on manual supervision, physical barricades, and on-ground decision-making by authorities. However, when crowd mass rises suddenly, human monitoring alone becomes inadequate. Delays in identifying risk situations can lead to stampedes, medical emergencies, or serious accidents.

AI-based crowd management systems help overcome these limitations by providing continuous monitoring, predictive analysis, and timely alerts. Artificial Intelligence systems process data collected from various sources such as CCTV cameras, drones, entry-exit counters, and mobile network signals. By using machine learning and computer vision techniques, these systems analyze crowd density, movement trends, and unusual behavioral patterns. During large-scale Navratri celebrations in Gujarat, AI-enabled surveillance systems can identify overcrowded areas at an early stage and alert authorities before the situation turns critical. One of the most important applications of AI in festival management is crowd prediction. AI models examine historical data from previous events, time-based attendance trends, weather conditions, and location capacity to estimate peak crowd hours. For example, weekends and celebrity Garba nights during Navratri generally attract a larger crowd.

A practical example of AI-assisted crowd management can be observed during Navratri celebrations at major Garba venues in Ahmedabad and Vadodara, where thousands of participants gather each night. These venues are monitored through CCTV cameras and drone surveillance, allowing authorities to track crowd density near entry-exit points, dance circles, and food zones. During peak hours, live monitoring helps identify congestion early and enables on-ground teams to redirect movement and manage queues efficiently. Such technology-supported supervision has improved emergency response time and reduced the risk of overcrowding during high-attendance Garba nights. With the help of predictive insights, event organizers can arrange additional security personnel, medical assistance, and volunteers in advance, thereby reducing safety risks. AI also strengthens event safety and emergency response mechanisms. Advanced monitoring systems equipped with facial recognition and behavior analysis can detect panic situations, sudden rush, or individuals collapsing due to health issues. Such systems immediately send alerts to control rooms, allowing authorities to respond quickly. These technology-driven measures support the crowd safety guidelines issued by the National Disaster Management Authority (NDMA) and assist Gujarat Police in coordinating faster and more organized emergency responses during mass celebrations. In situations involving fire hazards, stampede threats, or medical emergencies, AI helps minimize response time and supports life-saving actions. Another significant advantage of AI-driven crowd management is its role in promoting sustainability. Smart monitoring reduces the need for more manpower deployment, controls unnecessary lighting usage, and optimizes the movement of emergency vehicles. AI-based traffic management systems also assist in diverting vehicles efficiently, reducing congestion and decreasing fuel burn. As a result, festival activities become safer while also contributing to environmental responsibility. The use of AI-powered drones has further improved surveillance during large gatherings. Drones provide a real-time top-down view of crowd movement and help monitor areas that are difficult to observe from ground level. This technology is particularly useful for open-ground Garba venues and long procession routes, where crowd distribution is spread across a wide area. Despite its advantages, the application of AI requires careful attention to ethical considerations. Issues related to data privacy, transparency, and duration of surveillance must be handled responsibly. AI systems should be deployed strictly for public safety purposes and not for unnecessary tracking of individuals. Clear guidelines, limited data storage, and public awareness are essential for building trust in AI-based crowd management technologies.



# Toran on Bhunga: The living Science of sustainability

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The Gujarati saying of 'દર એક મંદર' culturally defines that we should worship, decorate and clean our house regularly as it is the temple itself. Torans and their deeply rooted connection to Indian culture and festivities are remarkable. The celebration of any festival in my house begins with the adorning of our door with a Toran which is more than just an ornament. Our forefathers found out that the leaves of sacred Ashoka or Asopalav tree (*Saraca asoca*) and Mango tree (*Mangifera indica*) were capable of keeping negative or evil spirits far away. Understanding the ancient texts will clarify the above statement. The Ashoka tree is believed to absorb the intense sorrow and grief of Mata Sita during her exile period where she was forcefully taken and kept under the shade of Ashoka tree by Ravana. Thus, the word "Ashoka" means "without grief/destroy all sorrow" and this justifies its name. The scientific studies suggest that cortisol levels remain balanced when the body comes in contact with the tree. The Mango signifies bringing wellness and prosperity according to Acharya Baldev Upadhyaya. Also, the research studies suggest that both these trees' leaves contain antimicrobial properties, phytochemicals, flavonoids and polyphenols which act as 'Bioaerosol Filters' and get released into the immediate airflow of the doorway and are intentionally kept at doorways serving as the disruptors of pathogenic life cycle. Additionally, the features such as locally sourced as well as being fully biodegradable contribute to sustainability. The tradition of preparing a toran was making garlands of fresh leaves and hanging at the main doorway of the house and to be changed periodically. Thus, research indicates an association with the wisdom of our elders. So far, the importance of Toran is discussed but as the article title reads "Toran on Bhunga...", you might have the curiosity regarding the word "Bhunga" so let's deep dive into the context. The term "Bhunga" refers to the traditional house; a distinctive circular mud hut found in the Rann of Kutch especially in Banni and Paccham region. For centuries, the Rabari, Ahir, and Meghwal tribal communities have not only thrived but also made possible for the humans to survive in the 40+ degrees Celsius in summers and below 5 degrees Celsius in winters in the vernacular architecture of Bhunga. The revised design of Bhungas is nearly 200 years old and the Kutchi people developed this innovative design after the devastating 1891 earthquake. It was found that the circular design, thick mud walls, what the engineers now call "shell action" are proven to withstand and resist the lateral stresses of an earthquake and also serves to be insulating against the outside harsh environment. It is noticeable that in the 2001 earthquake, many of the Bhungas stood sturdy while few of them which couldn't, were not maintained properly or were made with poor quality of components.

These sustainable shelters required regular plastering of the inner walls which was also made up of mixture of clay, mud and cow/donkey dung and replacement of old dried grass thatched on the roof. The females took the lead in bringing the art of mud and mirrors to life by decorating the inner walls of the Bhungas by their own creativity on every auspicious festival or celebration.

This environment-friendly yet must necessary practice found its place in festival traditions in the form of 'Lippan Art' or 'Chittar Kaam' originated by women residing in the Bhungas. The process of making Lippan Art was done by plastering the inner wall with composite mixture of sand, mud and clay in such a way that it gives a rough texture to the wall. They believed that mirrors helped in warding off-evil and that's why mirrors became an integral part of the Kutchi handicraft and Bhungas. If we look at the climate conditions and flora of White desert, it is noticeable that neem and khajoor trees are found. So, a basic question arrives like how come the Toran of Mango leaves or Ashoka leaves was made or any other alternative was used? The answer to this question is that yes Torans were used but instead of tree leaves, pendants in shape of leaves called 'pattis' were used. Along with mirror pieces, tassels, beads onto a string of cloth piece were tied. Culturally, the shimmering effect due to mirrors caused an illusion or state of confusion to the evil spirits. Also, many significant symbols such as elephants, parrots, sun and moon were used in embroidery which also contributed in bringing essence of piety and positivity. Hence, the hand crafted Toran also carries the essence of rich culture festivities and rituals for special occasions such as marriages, harvest festival, Navratri, Gujarati new year and many more. The Living Science behind the Toran, Bhungas and Lippan art is also fascinating. The torans help reducing the microbial load present in the air due to the leaves' property of being anti-microbial and regular changing of toran with new leaves helps breaking the pathogen cycle. The Bhungas when plastered with the cow/donkey dung, serve as platform where it inhibits the growth of disease-causing bacteria. Studies also reveal that the few strains of Bacillus and fungi were not able to colonize on this natural plaster due to competitive inhibition as well as the alkaline pH of the surface and bio-film production also stopped under laboratory conditions. Of course, the heat insulating factor of Bhungas is indigenous while it is also one of the few known vernacular structures made up of natural substances which can withstand earthquake. The Lippan Art is also possible due to the binding property of fiber with clay which keeps the earthy fragrance inside the Bhungas intact. Definitely habituating inside the traditional Kutchi mud hut and experiencing the handmade lippan art embedded onto the walls will be an unforgettable experience. Truly the gift of Lippan art and the amazing architectural design of Bhunga is a testimonial from our elders who had the wise vision of understanding the core of every aspect which today's generation is finding difficult. The use of Toran and renewal of Lippan Art of Bhunga in every festival is a healthy habit, eco-friendly and sustainable too! Like what our ancestors took from the nature valued it and after its purpose fulfillment, returned it back to the nature making the cycle complete and ongoing. This reflects how deeply our ancestors had great respect, understanding and love towards the nature. They truly understood the lesson of sustainability and implemented it too. In conclusion I wanted to highlight that our elders not only believed in practicing the tradition they laid the foundation of designing the survival systems. By blending the vital practices into festivals and auspicious days, they ensured that their wisdom get pass onto upcoming generations. They recognized that adorning the door with leafy toran would act as a protective shield against evil-like bacteria and ensure the health of the family. Also, the renewal of dung/clay paster in the form of Lippan art would make the Bhunga resistant to earthquakes. Hence, being a part of Gen Z generation believing on scientific studies, we must stop neglecting our heritage and traditional practices as 'outdated' simply because we haven't yet asked "Why?". It is the time to align our ancestral wisdom with scientific curiosity, proving that True innovation doesn't always require new technology-sometimes, it just requires looking at our roots through a microscope.



# Community Leadership: From Garba, Kites to Pandals in Gujarat

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Leadership is generally associated with offices, the workplace and corporate world where you might see a boss who tells you what to do and for which you are getting paid. But the reality lies far away from this: leadership starts from domestic discipline rather than professional one. It exists where people come together either in our home or a community. Communities during festivals exhibit a natural sense of leadership without any individual authority or organizational charts. They show that communities don't always need designation or salaries but trust, responsibility and shared purpose. But in reality, unity doesn't always come without conflict, managing the conflict is what gives stronger support and acceptance. Hence in this article we will see how leadership and coordination in community is a classroom of experiencing success of festive events while managing conflicts efficiently with the example of festivals in Gujarat. This article connects leadership and team coordination in communities with Organizational Behaviour (OB) particularly Maslow and Herzberg's theory of motivation and to show how leadership works beyond formal organizations. Then we can relate this with real life examples of how traditional festivals of Gujarat such as Navratri (Garba), Makar Sankranti, Ganesh Chaturthi and Durga Puja are managed and without proper leadership and coordination even joyful celebration in social settings can become disorganized. Why Leadership and Team coordination is needed beyond formal Organizations? Every community festival or event involves participants such as volunteers, residents, performers, vendors and local authorities which come in large numbers. Their decisions related to safety, responsibilities, scheduling, permissions and budgeting should be taken carefully. Even volunteering setups and coordination is equally important. Hence leadership acts as a binding force and helps in maintaining motivation, allocating roles, planning and resolving obstacles.



This creates a shared sense of purpose and helps in giving people in mass a direction to move consistently. While Leadership provides a role and direction it is coordination which provides fruitful results by working efficiently for their goal. Hence neither authority nor disciple can do work alone. Garba nights, Makar Sankranti, Ganesh Chaturthi and Durga Puja happen with the participation of numerous people from all over the locality in Gujarat. All because of a sense of fulfillment and pride in preserving their culture and serving the community to foster belonging and togetherness is explained by Malow's theory stating Self-actualization and Social needs and Herzberg's hygiene factors. Whereas the respect, recognition and responsibility from the participation encourages commitment and showcases Maslow's hierarchy of needs and Herzberg's motivators. They emphasize that without monetary benefits and formal designated authority people still showcase a sense of team coordination because of the pride and respect which comes from the society. Ground Reality Insights of Leadership and Team Coordination. From what we read in textbooks, reality does not always show the exact similarity. Festivals do bring everyone together but it also brings diverse opinions and conflicts over cultural preferences, funding, scheduling and environmental factors. Team coordination brings the community together by handling these issues efficiently not only by authority but by taking the opinions of senior members, satisfying dialogues and bringing harmony from long term ideas of resolution. For e.g. Navratri brings use of loud speakers which were limited to be used between 10 to 75 decibels and prohibited from 10 p.m. to 6 a.m. banned within 100 meters of hospitals, educational institutions, and courts aligning closely with OB principles of sustainable team functioning. Despite limited resources events often run smoothly due to trust and clarity in roles such as Sheri Garba in Gujarat is organized by committees at the neighbourhood level. As everyone love to enjoy the cultural celebration through dance and music.

It often shows the use of reuse of major resources such as DJ's, decoration material and outfits are often re-used every year. Local vendors get surge in sale and consumer spending as physical exercise creates high demand of at late-night snacks and foods. Makar Sankranti on the other side represents the unique form of leadership with no central authority and formal structure. As this festival progresses on rooftops, societies or open grounds yet coordination happens effortlessly. People share huge spaces and norms are made for regulating appropriate behaviours. For one day people see huge demand of kites and charkhas and maintaining cleanliness. Team coordination is seen through various NGO's protecting injured birds and ban of Chinese manjha and Karuna Abhiyan from government in Gujarat. Another example of leadership is service oriented which comes from celebrating Christmas. Consisting its deep historical roots from presence of Portuguese in Daman/Diu and British trade in Surat in early 1600s. It is celebrated vibrantly with communal feasts, lights, festive meals and midnight masses blending beautifully with Gujarat's cultural warmth and festive spirit. Ganesh Chaturthi, which is associated with Maharashtra, has become widely celebrated in Gujarat. Leadership and coordination showcase through production and selling of Idols made from clay rather than Plaster of Paris (P.O.P.) and crowd management during immersion. This created an environmentally sustainable festival not just a religious event. Similar to this is Durga Puja reflecting cultural influence and inclusivity. Originally rooted from Bengal, it has found its joyful space in urban communities. Today it is celebrated with same enthusiasm in whole India not just in West Bengal through structured leadership and early planning, finance, decoration, logistics management through volunteer and Team coordination. Conclusion: Community festivals showcased in Gujarat is a model for Team coordination and Leadership where the sky filled with kites to church carols to Ganesh Chaturthi and Durga puja pandals to World renowned Navratri celebration offering strong sense of pride and inclusivity. Hence, it's not only offices or study spaces where Leadership & management is used and learnt but also from the real-life applications from the festivals which our culture has been celebrating from more than decades. Our festivals have always provided the knowledge of team coordination and communal leadership which is acknowledged by whole world & seen in a positive strength from religious events. India and its festivals always display sense of leadership and coordination from its community festivals expressing unity in diversity. Once rooted in our culture, Leadership & Team coordination has become fundamental community-based skills and can be seen in various time of year & season in Gujarat.



# The Physics of Why Earthen Lamps Feels Calmer Than Electric Lights.

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How a Small Flame Creates Big Peace Why lighting a simple earthen lamp changes a room — and how Diwali turns that private calm into a public one Why does a single diya change the feel of a room the instant it's lit? Why do conversations slow, voices soften and minds seem to loosen — without anyone announcing it? Because a tiny flame quietly speaks to parts of us older than words. Inside that small, steady light is a meeting of physics, biology, memory and feeling — a relationship that started when humans were still learning how to live with the night. And nowhere does that meeting show up more clearly, or more powerfully, than on Diwali . When the Night Was Stronger Than Us. Shyam wasn't hunting for science the first time he noticed a diya. He was eight, sitting on his grandmother's cool kitchen floor as evening poured into the village — no phones, no bright bulbs, just dusk rolling like a blanket. His grandmother set a small clay lamp by the doorway, poured oil, tucked the wick and touched flame to cotton. The light appeared and behaved nothing like electric light . It trembled, leaned, breathed — then steadied. Shyam leaned forward. "Why does everyone get quiet when you light it?" he asked. His grandmother watched the flame and smiled. "Because," she said softly, "this light came when we were afraid of the dark." Long before electricity, night erased edges and sharpened sound. Fear moved faster than sight. Fire didn't just illuminate — it reassured. The diya is what people made when they decided the night could be met with something small and trustworthy. A Flame Built to Be Gentle Early humans learned that fire could be controlled: small, predictable, tame. Clay — earthy and matte — held heat and let it go slowly. Oil burned steadily. Cotton fed the flame without drama. Nothing about the diya is accidental. Its flicker is gentle, rhythmic . Neuroscience now finds that rhythm calming: it matches brain states tied to relaxed attention and safety. In plain terms: The flame speaks the body's language. Shyam didn't know the words. He only felt it — breathing slower, shoulders softening, thoughts settling. Not faith. Biology meeting physics . Light the Body Knows A diya's color — amber, gold, soft orange — sits low on the light scale, like sunset. For tens of thousands of years our nervous systems learned under light like this. Warm, low light: a) reduces eye strain b) eases stress hormones c) signals the brain that the day is winding down. The parasympathetic system — our "rest and restore" mode — leans in. Heart rate drops. Muscles relax. Thoughts unsharp. People felt this long before they had words for it. From Survival Tool to Ritual Anchor As villages turned into homes and nights felt safer, the diya didn't disappear. It shifted. From necessity to signal. From tool to ritual. Placed at doorways, along windows, in courtyards, the diya became a border between the outside and an inner calm. Lighting one told the nervous system: You are safe now. Over time, that small act gathered layers of meaning until it was woven into family rhythms. Diwali: When One Flame Becomes Millions Diwali is called the festival of lights for good reason — symbolically it's light over darkness, hope over fear. But on a human level, it's something else too: a mass practice in emotional regulation. On Diwali night, whole neighborhoods glow with warm, breathing light. Harsh white bulbs are softened or joined by rows of clay lamps. Thousands of small flames replace one relentless glare. What happens: a) visual field becomes uniformly warm b) the light flickers instead of sitting rigid c) brightness is spread across many sources, not concentrated in one The result is a collective easing of sensory tension.



People don't just see the night differently — they feel it differently. How Diwali Calms Even When It's Loud Diwali can be loud, crowded, brimming with motion. And yet, there's a surprising softness beneath the bustle. Children nestle by lamps. Elders pause. Conversations stretch and deepen. Even excitement carries a gentler edge. When a space is filled with warm, rhythmic light, the brain lowers its threat mode. The amygdala — the part that scans for danger — quiets. Attention relaxes and turns inward. In short: people feel safe together. Diwali doesn't just brighten houses. It synchronizes hearts. The Design of Calm Traditional Diwali lighting follows patterns modern wellness designers now copy: a) lamps low to the ground b) light spread horizontally, not from above c) many small sources instead of one bright one This avoids glare and harsh shadows and resembles the firelit environments humans lived in for million years. Without modern neuroscience, Diwali's designers got the architecture of calm right. The Power of Doing Things Slowly Lighting a diya takes time. You clean the lamp. Pour the oil. Tuck the wick. Bend down and wait for the flame to settle. That slowness matters. Psychologists call it intentional slowing — a deliberate pause that pulls the mind into the present. Long before guests arrive, before festivities begin, the household's nervous system is already shifting. Diwali begins in the body. Why Children Remember Diwali Ask adults for their childhood Diwali memories and they rarely tell stories first. They recall sensations: a) the glow on the walls b) the warmth on faces c) the hush before the fireworks d) the stillness before the noise Calm brains encode memories differently. Joy mixed with safety stays vivid. The diya becomes a kind of memory hardware — small light, big imprint. Electric Light vs. Diwali Light Electric lights are efficient and bright — but they're demanding. They flip on abruptly and often carry blue-heavy tones that tell the brain: Stay alert. Diwali light asks for the opposite. It flickers. It breathes. It invites presence rather than productivity. Even in modern homes, the evening feels incomplete without those lamps. The nervous system notices what the mind might not. Tradition as Tacit Neuroscience suggests What makes Diwali remarkable is continuity. For thousands of years, the festival has reproduced a sensory environment — patterned, repeated, passed down. No lab notes. No manuals. Just collective experience preserving what science would later name. Science didn't invent the diya. It learned its language. A Flame That Still Understands Us Years later, Shyam learned the physics behind a flame. He could explain wavelengths, combustion, heat transfer. But on a long day, when he lights a diya in his room, it's not theory that draws him. It's a memory. It's the body remembering something older than explanation. The diya is not an artifact of a past people. It is an interface — between humans and night, between fear and calm — that still knows how to speak to us. Sometimes the wisest knowledge is the simplest: A small flame that still understands how we feel.

## My Navratri Journey: Where Devotion, Dance, and Science Unite

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Navratri has always held a special place in my heart, but this year it became truly transformative. Amidst professional responsibilities and family life, I chose to immerse myself completely in the spirit of the festival by adorning a traditional Kutchi work chaniya choli. The intricate embroidery, vibrant colours, and rhythmic movement of the attire made me feel deeply rooted in tradition. As the beats of the dhol filled the air each evening, I felt a powerful surge of energy—one that was both emotional and physiological. Balancing work, motherhood, and nine consecutive nights of Garba might appear physically demanding, yet I experienced remarkable vitality throughout. From a biological standpoint, Garba functions as an effective full-body aerobic exercise. The continuous circular movements enhance cardiovascular endurance, improve blood circulation, and increase oxygen delivery to the brain. Sustained physical activity also stimulates the release of endorphins—natural mood enhancers that reduce stress, elevate focus, and generate a lasting sense of well-being. This scientific response explains the sustained energy and mental clarity I experienced night after night. Equally significant is the neurological and emotional impact of group dancing. Garba is performed in synchrony, fostering collective rhythm and unity. Neuroscience explains that such synchronized movement stimulates the release of oxytocin, commonly known as the “bonding hormone,” which strengthens social connection and emotional security. Dancing alongside friends and fellow devotees created a shared emotional resonance—one that fostered joy, belonging, and inner peace beyond what solitary activities can provide. On a deeper level, Garba is not merely a dance but a spiritual expression. Dancing in devotion to Mataji instilled a sense of discipline, surrender, and resilience. The repetition of movement across nine nights symbolized endurance and faith, reinforcing mental strength and emotional balance. This integration of spiritual devotion with physiological engagement created a powerful mind-body harmony that sustained me throughout the festival. Being honoured with the Best Costume and Garba Award was a deeply humbling moment. It represented more than aesthetic appreciation—it acknowledged dedication, cultural pride, and the spirit behind the performance. My Navratri journey reaffirmed a profound truth: when tradition, science, and devotion unite, they generate a powerful source of strength, wellness, and joy. Garba, for me, became not just a celebration, but a living expression of balance between body, mind, and soul.



# Food Science Behind Traditional Gujarati Festive Sweets

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The festivals of Gujarat are much more than the dates that appears on a calendar: They are tapestries of devotion, music, colour and culinary heritage. Although the rhythmic beats of Garba and the swirling Chanya cholis may dominate the image of celebration, the heart of the festival lies in its kitchen. The delicacies prepared in each Gujarati household, ranging from Mohanthal, Churma Laddu, Aadadhya Pak, Lapsi, and Ghari to rustic Pithu, are not merely sweets; but living memories, cultural embodiments, and edible blessings passed down from generation to generation. Nestled between the rich velvet of ghee and the sweet comfort of jaggery we find chemistry, agriculture, and traditional food science. Gujarat's ancestors had a keen understanding of the science of nourishment long before contemporary nutritional research was developed. The ancestors of Gujarat knew that Aadadhya Pak provided warmth against the cold of winter; and that the complex carbohydrates present in Lapsi supplied the energy needed for the performance of rituals and celebrations. Hence, it is evident that these dishes contain an exquisite fusion of culinary artistry and scientific knowledge; which can be traced through the theme "The Science of Gujarat's Festive Spirit."

“મોહનથાળની મહેકમાં મમતા મળી જાય, ગુજરાતની મીઠાઈઓમાં તહેવાર જીવાંત થઈ જાય.” Mohanthal: Mohanthal is a sweet preparation traditionally made at Diwali, Janmashtami and weddings, and is embedded in the temple culture of the Vaishnavas, where the sweets offered to Lord Krishna were made to represent purity and prosperity. The actual name “Mohanthal meaning Krishna's Plate” indicates its beginnings as a religious offering of devotion. Mohanthal is best noted for its distinctive danedar (grainy) texture, created by pouring hot ghee over roasted gram flour before roasting, and this step is essential for developing the distinctive flavour profile for Mohanthal as well as the unique aroma and color (golden brown) due to the Maillard reaction (the complex reaction between proteins and sugars when exposed to heat) which provide the distinctive caramelized flavour that defines Mohanthal. As Mohanthal contains high levels of ghee, it is an excellent source of slow-releasing energy and is often used by devotees during long religious ceremonies and periods of fasting. Different regions of Gujarat have different variations, with Saurashtra preparing a relatively coarser, grainier version, whereas central Gujarat typically makes a smoother version. Churma Laddu: Churma laddu was originally used as a food source for people during the Festival of Ganesh Chaturthi, winter weather, and during harvest times. The churma laddu originated from the dietary practices of pastoral and agricultural communities in Gujarat and Rajasthan. Pastoralists were the herdsmen and the agricultural communities were the farmers. They needed to have a very concentrated, easily carried, and a long storage life energy source. Because of this, churma was invented to meet the energy needs of the herdsmen. Churma consisted of crushed fried wheat combined with jaggery. On a scientific level, the combination of carbohydrates from wheat and minerals from jaggery provides a complete nutrient profile. Additionally, jaggery supplies iron, magnesium, and polyphenols, which are good antioxidants for the body. Laddus are round in shape, which decreases the possibility of oxidation, and allows laddus to hold their moisture longer. This characteristic extends the shelf life of the laddus. Ghee enhances the flavour of the food and promotes better digestion of the laddus and is particularly prized in colder areas of India, such as Banaskantha and Kutch.





#### Aadamhya Pak:

Aadamhya Pak, or Adadiya Pak, appropriately referred to as a 'dietary treatment' following childbirth for both winter and postpartum recovery, contains several traditional sweeteners which are passed through generations via midwives, family traditions and social practices based on geographic location and community culture. The genius of this particular formulation is demonstrated through the individual ingredients used to prepare it: Gond, or edible gum, expands when it is fried; it will become very light and easy to digest and provides necessary building blocks for the repair of tissues after giving birth. Dry ginger has a thermogenic effect, and facilitates an increase in warmth and speed up metabolism. Fenugreek has lubricating properties for joints and supports healing after childbirth. The high fat content from the ghee provides extended energy supply, and improves nutrient absorption. Aadamhya Pak illustrates how foods of cultural significance can serve as 'functional foods' and therefore provide protection for emotional and physiological needs.

Lapsi: Lapsi is a popular Gujarati sweet prepared during numerous cultural celebratory occasions, including the following: Dhanteras, Navratri, New Year, Housewarming celebrations, and other Life Events and Milestones. The Historical Manuscripts refer to the preparation of Lapsi as an ideal "Naivedhya" or Food Offering in Hindu Temples; therefore, it is believed that Food Represented Purity, Prosperity, and Fortunate Beginnings. Lapsi consists of Cracked Wheat (Dalia), Ghee, and either Jaggery or Sugar, which is why the dish has high nutritional value. Cracked Wheat Contains both Bran and Fiber, Therefore Cracked Wheat will provide a slow release of Glucose resulting in better glycemic control. Roasting the Grains in Ghee activates the Mild Maillard Reaction Resulting in the Aroma to become enhanced, While the Fiber Parts of the Grain will be made soft and more digestible, Making the dish properly cooked and nutritious. Although Lapsi is primarily prepared during the winter months, people prefer to consume Lapsi due to the fact that Jaggery is rich in minerals; whereas, Lapsi prepared with Sugar can be consumed throughout the Year.

Ghari: Surat Ghari, which celebrates the festival of Chandani Padva, is rich and precious as it has an unexpected backstory. Cooks in Surat made Ghari to provide sustenance for soldiers who were part of the 1857 uprising, fighting alongside Tatya Tope. Ghari contains high-density ingredients and has a long shelf life, especially suitable for wartime use. The reason for Ghari being associated with science has to do with its ingredients including mawa, ghee, sugar, and nuts. The high level of fat inhibits water activity. Therefore, the level of microbes growing on food products will be reduced, which helps to extend the safe storage periods of Ghari. Additionally, the layer of ghee on top provides a natural barrier to preserve the quality by increasing its shelf life. With the passage of time, various types of Ghari were developed in Surat. Some of these types were made with pistachios, kesar and almonds, illustrating the trade history of the region.

Pithu of Dang: Amongst the festive Sweets of Gujarat, Pithu from the Dang Tribal Community exemplifies the nutritional wisdom of simple restorative foods. It combines the attributes of a baked Cake and steamed Pudding by using slow cooking methods rather than frying. As a product of Rice Flour and Milk. The batter is slowly cooked over a wood fire until firm, sweetened with either Jaggery or Sugar and flavored with Cardamom and Nuts. Pithu is a vital example of the basic food science principles: During Starch Gelatinization, Rice Flour absorbs water and swells. During Coagulation, Milk Proteins create structure and the soft stable texture of Pithu. The completed dish will provide sustaining energy without causing spike in glycemic levels. Addition of Fruits and Nuts in Pithu creates a balanced source of healthy Fats, Proteins, and Carbohydrates making it the perfect food for the active lifestyle of the Tribal Communities who eat it. The symbolism of Pithu in Dangi Culture comes from the farm to table ideal, and is served at weddings and harvest festivals.

Conclusion: Sweetness surpasses the notion of simply providing sustenance to people from Gujarat and becomes a source of sweet memories; a sign of God's blessings; and a way to celebrate unity among family and friends. There are many varieties of sweets, including Lapsi's warm flavor as it warms you through the winter months; Mohanthal's sweet and festive aroma during times of celebration; Aadamhya Pak's dense and dark richness when you need extra energy; Pithu's very earthy and nutty flavor and texture; and Churma and Ghari carry the rich history of Gujarat. All these varieties of sweets represent a deeper story than just taste or nourishment. The true uniqueness of these sweets comes from their combination of science and soul. Every texture of each variety is the result of our ancestors using scientific principles and methods to develop their recipes with the knowledge that it would feed and sustain them. There are so many wonderful aromas emanating from various types of sweets and each aroma provides a sense of nostalgia for our families and community. By creating various recipes for the development of our sweets, we can honor the legacy of our ancestors, celebrate the masses of natural resources that are available within the community; demonstrate the love that we all share for one another. The time-honored manner in which our ancestors produced and consumed these types of sweets has always reminded us of the joy that these types of recipes provide an additional dimension to the sweetness of each celebration or holiday.

# Food Science Behind Traditional Gujarati Festive Sweets (Fafda, Jalebi, Mohanthal)

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If you have ever visited Gujarat to celebrate a festival, you must be knowing that the culture and the food are the two sides of a same coin. Fafda, Jalebi, and Mohanthal are not just delicious treats but are a blend of sciences in the kitchen. Long before when "food science" degree was even discovered, our ancestors were lab technicians in the kitchen. They understood exactly how to modify protein structures, control the sugar crystals, and manage the heat to create textures and flavours that are still winning everyone's hearts. Cooking isn't just about treating yourself to something delicious, it's about building a lasting impact of eco-friendly traditional techniques. Let's learn about the cool science behind these pots and pans with we've all grown up with. The science simmering in Besan As these treats (Fafda and Mohanthal) are made up mainly of Besan, Let us take a look at the miracles of Besan. Besan, comes from the Bengal gram is not just the star of the show because it tastes amazing but also has a lot of nutrition in it. Besan has about 20% protein and loads of complex carbohydrates that keep you energetic all day along. Besan has zero gluten. In wheat flour, gluten is the sticky glue that holds everything together in a dough. In Besan, without gluten, the traditional cooks had to think creatively in the kitchen to figure out the clever ways to bind, stretch, and shape the sweets. It is the evidence of their smartness, turning a disadvantage into delicious and sustainable eats. Chemistry behind Fafda Fafda is one of the most demanding snack of Gujarat. If you mix chickpea flour with water, you'll get a sticky dough that tears up instantly. The magic ingredient is Papad Khar (or baking soda). It is responsible for the fluffiness and is also a chemical agent, responsible for alkalinity. The alkalinity of the baking soda reacts with the protein molecules in the gram flour and uncoils it. This creates the elastic gluten-like network found in wheat. This chemical modification allows the artisan to stretch the dough on a wooden board into paper-thin strips without breaking. Additionally, some spices like Asafoetida (Hing) and Carom seeds (Ajwain) are adding the extra flavours. Hing: Its pungent compounds breaks down into savory, onion-like flavors when fried. It also helps in preservation of the snack. Ajwain: Helps in digestion and is a natural preservative with good taste. Then the raw dough is deep-fried, transforming it into golden, crispy snacks that involves the complex lipid chemistry and thermal reactions.

When Fafda is deep-fried in moderately hot oil approximately at 160-180°C, the moisture content of the dough evaporates quickly and generates the steam that creates the characteristic porous and crispy texture of Fafda. Simultaneously, the oil temperature triggers several chemical transformations; - Starches present in the gram flour gelatinize (absorbs the water and swells up) - Proteins further denatures and aggregates - The dough's surface undergoes the Maillard reaction (a non-enzymatic browning process that creates the pleasing golden color and crazy flavours through reactions between amino acids and reducing sugars). Over-frying causes oxidative degradation of unsaturated fatty acids in the oil which leads to the formation of free fatty acids, hydroperoxides and polymeric compounds. The rate and the extent of these chemical changes depend on factors: - The fatty acid composition of the frying oil - Temperature - Frying duration and - Exposure of atmospheric oxygen. Therefore, the traditional Gujarati cooking practices address this challenge through their cultural knowledge; Fafda is fried for a few minutes only in moderately hot oil which minimizes the oxidative damage. Walking through the vibrant streets of Gujarat, the sight of a halwai swirling batter into hot oil is a live demonstration of science behind the traditions. To a normal person, it's just a sweet. But to a person with scientist-like brain, it's a brilliant display of preservation and texture. The journey begins with a simple mix of flour and yogurt, but the real work is done by microscopic residents or the bacteria present in the yogurt. As the batter rests, natural bacteria transform the dough, giving it a distinct tang that acts as a necessary counterweight to the intense sugar to come. This process doesn't just add flavour but also alters the protein structure of the flour, creating a "stretchy" strength that allows the jalebi to maintain its delicate, thin shape without snapping in the heat. Engineering the "Crunch" When the batter hits the bubbling oil, a quick chemical reaction occurs. Heat-activated leavening agents release gas, inflating the jalebi from within. This creates a hidden, honeycomb-like network of internal chambers. These aren't just for texture—they are essential "storage tanks" designed to hold the syrup that follows. The Physics of the Glaze The sugar syrup is the final, critical step. By heating the sugar until it reaches a specific density, the cook ensures it is thin enough to flood those internal chambers but thick enough to "set" upon contact with the air. As the temperature drops, the sugar molecules lock together into a glassy, crystalline shell. This provides that iconic "snap" when you bite into it, followed immediately by the release of the warm liquid trapped inside. Ancient Preservation Beyond the taste, there is a survival strategy at play. While high-heat frying removes some nutrients, the saturation in sugar is a deliberate act of biological defense. By binding the available moisture, the sugar makes it impossible for spoilage-causing bacteria to survive. This "old-world" preservation technique allows these golden spirals to remain safe and delicious for days, even in the warm Indian climate.





Mohanthal is an crumbly Gujarati fudge. More than a sweet, it's a cozy blend of science and tradition. Made from roasted gram flour, ghee, and sugar syrup, it melts in your mouth like a warm hug. Let's break it down like a chat over chai. The Roasting Magic: Flavor from Heat and Stir Imagine ghee bubbling at 130-160°C in your pan. Add room-temp gram flour (20-25°C), and the Maillard reaction kicks in a chemical dance between proteins and sugars creating nutty, golden flavors. Stir for 10-20 minutes as it shifts from pale yellow to caramel brown. Early on, simple notes like aldehydes emerge; overdo it, and bitterness creeps in. Gujarati cooks master this with low heat and constant stirring, avoiding burns. It's the same precision scientists use, turning plain flour into something extraordinary. That Irresistible Grainy Texture Before roasting, mix coarse gram flour with ghee and milk, rub it between your palms until crumbly, then rest and sieve. This isn't random milk softens proteins, ghee prevents clumping, and rubbing creates ghee-coated particles for that "danedar" graininess. During roasting, fats seep in, starches swell, and proteins link up. Stirring keeps particles separate, yielding crumbly bits that dissolve individually on your tongue. The Sweet Union: Syrup and Flour Pour hot sugar syrup (112°C, 85-90% sugar) into warm roasted flour. As it cools, sugar crystallizes around flour particles, forming tiny crystals for a smooth, melty texture. Too hot, and it turns gooey; too cool, and it's hard. Makers feel the moment by touch is a pure intuition. Ghee: Flavor's Stable Sidekick Ghee, mostly saturated triglycerides, handles high heat (smoke point 190°C) without rancidity. It preserves Mohanthal for months without fridges, using local dairy sustainably is a no waste. Tradition's Timeless Wisdom Mohanthal embodies eco-smarts: local ingredients, zero waste (scraps for eating or feed), and natural preservation via roasting and sugar. It's sustainable living in every bite, blending old ways with modern principles.

#### Conclusion

The traditional Gujarati festive sweets ; fafda, jalebi, and mohanthal represents far more than culinary indulgences; they embody sophisticated food science principles developed through centuries of empirical refinement. From the protein chemistry of gram flour dough to the crystallization dynamics of sugar syrups to the thermal processing mastery demonstrated in mohanthal roasting, these sweets demonstrate that traditional knowledge systems possessed deep understanding of food science principles, often articulated through cultural practices rather than molecular terminology. Moreover, these sweets exemplify sustainable food production approaches that modern food science increasingly recognizes as essential responses to environmental challenges. By utilizing locally-available plant-based ingredients, minimizing waste, incorporating natural antimicrobial spices, and employing thermal processing to extend shelf life without chemical preservatives, traditional sweet-making represents a scientifically-grounded sustainable system. As global food systems face pressure from climate change, resource depletion, and consumer demand for natural products, the principles embodied in traditional Gujarati sweets offer valuable lessons in achieving both culinary excellence and environmental sustainability. These beloved sweets continue to nourish body and spirit during festivals, carrying forward both the nutritional wisdom and sustainable practices of generations past.

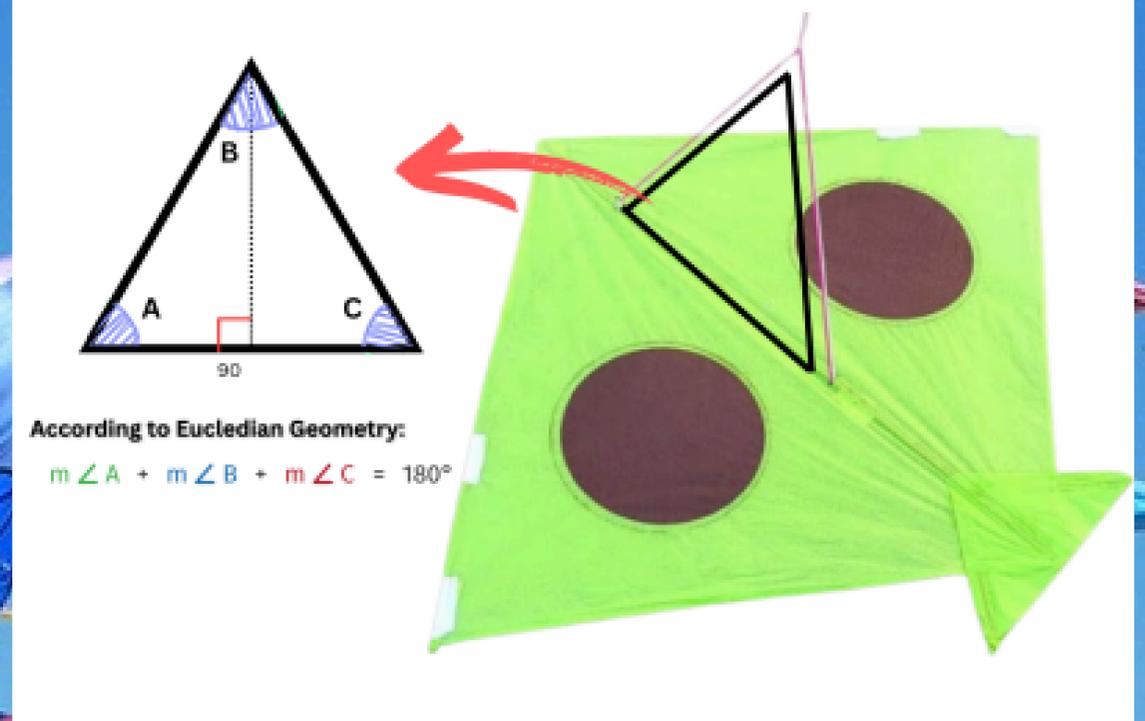
# The Unseen Mathematics of 'Kai Po Che !'

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It is a ritual that repeats itself every year, on the morning of January 14th. It is the morning of January 14th. You are standing on a terrace in Gujarat. The air smells of winter sun, sesame seeds and Undhiyu. But if you look up, the sky is no longer blue. It is a chaotic, vibrant mosaic. Thousands of paper diamonds are dancing in the wind. The noise is deafening, not from traffic or anything, but from the collective roar of a city looking upward. "Lapet!" "Kai Po Che!" It is not just a celebration, it is a tradition. But I want you to pause for a moment. Look away from the spectacle in the sky and look into the corner of that terrace. There is a ten-year-old boy. Let's call him Piyush, who is holding a firki (spool) in one hand and a kite in the other. He is sweating with frustration. For the third time in ten minutes, his kite has failed him. Whenever he tries to fly the kite, it spins wildly, enters a spiral and crashes nose-first into the neighbor's balcony. He looks at the boy on the next roof, a rival who is effortlessly commanding a huge black kite high in the clouds. Piyush turns to his grandfather and asks the question that has puzzled children for generations: "Dada ji, why does his kite fly, but mine falls? Is his paper better? Is his string stronger? Why does the wind hate me?" The old man smiles, wordless. He takes the broken kite, but not to change the paper or pray over it. Instead, he simply adjusts a knot. With a micro-adjustment the naked eye would miss, he slides the bridle thread just one millimeter to the left. Handing it back, he whispers, "Try now". And this time? The kite soars. It shoots straight up, piercing the wind, steady as a rock. It joins the army in the sky. But ask yourself this: What did the grandfather just do? Was it magic? Was it luck? No. Whatever you call it tradition, skill or haath ki safai, it is actually something else entirely. It is Physics and also a little bit of Mathematics. That old man on the terrace is unknowingly applying the same laws of aerodynamics that engineers use to keep an airplane in the air. The story of this flight begins the night before, in the living room, with the tying of that knot (the Kanni). To Piyush, the Kanni looks like a simple string tied to the bamboo spine. But have you ever stopped to wonder why the tied strings form a triangle? Why don't we just tie one string in the middle? When the grandfather took the kite from Piyush, he wasn't fixing a knot, but rather he was solving a geometry problem. Imagine sitting on the bank of a river or a lake and you are trying to skip a flat stone on a river. Why does it bounce? Because you throw it at a specific angle. If you throw the stone nose-down, it dives and sinks instantly. If you throw it too flat, it drags. You need that perfect, slight upward tilt for the water to catch it and throw it back up into the air. The kite is just a stone skipping in the wind.

The kite works the exact same way. The triangle of the Kanni determines the "Angle of Attack." Piyush's mistake was simple: his knot was slightly off-center. The angle was too steep, so the wind hit the kite like a wall, causing it to crash. When Dada ji adjusted the knot, he found "The Magic Ratio" which is not too steep, not too flat, but just right. He didn't need a calculator. He used his thumb. But made no mistake: the math was flawless. To really understand the magic, look at the diagram below. The bridle isn't just a string, it's a perfect Euclidean triangle. The bamboo spine forms the base, and the two strings meet at the top point to form the top vertex. What Dada ji was doing was a real-time application of a fundamental geometric theorem: The sum of angles in a triangle is always 180 degrees ( $m\angle A + m\angle B + m\angle C = 180^\circ$ ). By adjusting the knot, he was changing the lengths of the triangle's sides. And in geometry, when you change the side lengths, you automatically change the angles. Piyush's "bad knot" created an asymmetrical triangle with extreme angles, forcing the kite into a steep, unstable stall. Dada ji's "magic knot" re-balanced the side lengths. This automatically adjusted angles A, B, and C into a harmonious relationship. It created a stable isosceles triangle where the forces of lift and drag were perfectly balanced. He didn't know any of this logic and mathematics behind this, but his fingers knew the geometry by heart and the practice he has been doing for years. He was unknowingly proving Euclid right. Now that the geometry is solved, the kite is in the air. As Piyush pulls the string, the kite climbs. It reaches about 150 feet and hovers there, dancing gently. But here lies the mystery. The kite has no engine and no propeller. It weighs less than a packet of chips. Gravity is trying to pull it down to Earth every single second. So, what is pushing it up? The answer lies in a rule of nature discovered by a Swiss mathematician named Daniel Bernoulli. Look at a kite in the sky. It is never straight, it is always tilted. When the wind hits the kite, the air has to travel over the top to get to the other side. Because of the tilt, the air on top has to run faster to catch up. And here is Bernoulli's magic rule: When air moves faster, its pressure drops. So, what is happening in the sky? The air above the kite is sprinting, creating a vacuum (Low Pressure). The air below is moving normally (High Pressure). High pressure pushes up. Low pressure sucks up. The result is a powerful force because of which our kite moves from High pressure to Low pressure which we call Lift. This science also explains one of the funniest sights of the festival. We have all seen it. The wind suddenly dies. The kites start to sink. Suddenly, you see hundreds of people on terraces running backward, jerking the thread violently. Why? Are they panicking?

No. They are instinctively being physicists. Bernoulli's principle requires air to move to make its claims remain true. If nature stops the wind, the human (the person flying the kite) must start the motion. By running backward, Piyush is trying to manufacture his own wind. He is literally converting his own muscle energy into flight. But let's be honest. Uttarayan is not just about flying. It is about the battle in the skies. Piyush's kite is now soaring high, but a predator appears. A small, agile yellow kite swoops down. Piyush freezes. The strings cross and after a second, "Lapet!" screams the neighbor. "Kheeeench!" (Pull!) shouts Dada ji. Piyush obeys. He yanks the thread violently towards himself. In a split second, the green kite is cut and flutters away. "Kai Po Che!" But pause and think. How did one cotton string cut another cotton string? They are the same material. Why did Piyush win? This is where aerodynamics turns into Material Science. The string (Manjha) is coated with finely crushed glass. To a physicist, this coating serves one purpose as it turns the smooth thread into a microscopic saw blade by increasing friction. Piyush won because he used the 'Pull' (Khench) strategy. In physics, this is called Impulse. By yanking the string suddenly, he generated a massive spike in friction heat at the single point where the strings touched. The heat melted the glue-and-glass bond of the opponent's string before Piyush's own string could snap. It wasn't just a pull, it was a calculated surgical strike on the opponent. However, every story has a conflict. And in the modern story of Uttarayan, the villain is our own innovation. As Piyush reels in his victorious kite, look at the trees around your city. Look at the birds. In Dada ji's time, science was sustainable. They used pure cotton thread. Cotton is organic, it has a breaking point. If a bird flew into it, the thread would snap. If it fell in a tree, it would rot away in a few months. Today, we tend to use Nylon(Chinese Manjha), which is a synthetic polymer. It is a miracle of chemistry, but a curse for the environment. It does not snap nor does it decompose rather it takes more than around 40 years to break down. We tried to "hack" the science to win more battles, but in doing so, we broke the safety valve that nature provided. The "Science of Flight" is beautiful, but the "Science of Materials" has become dangerous for us and the nature around us in the current times. As the sun sets and the paper lanterns (Tukkals) float up, Piyush sits with his grandfather. He is tired. His fingers are taped up. He doesn't realize it, but today, he wasn't just a boy playing a game. When he tied the knot, he was an Engineer. When he launched the kite, he was a Pilot. When he fought the battle, he was a Physicist. And that is the true magic of this day. We call it Uttarayan. But in reality? It is the world's happiest open-air classroom. And the best part is, you don't need a textbook to understand it. You just need to look up, feel the wind, and let your spirit soar along with the kites.



Conclusion: Gujarat's festive spirit is colorful, loud and delightfully chaotic. But look deeper. Beneath that chaos, there is a beautiful harmony. It is where science dances with tradition and where the laws of physics and mathematics turn into pure joy. As the night deepens, Piyush looks at his grandfather. Dada ji isn't watching the kites anymore, he is watching Piyush, with a smile that says more than any mathematics or science textbook ever could. And perhaps, that is the final secret. We can analyze the angles, calculate the lift, and debate the friction. But at the end of the day, Uttarayan isn't just about the war in the sky. It is about the beautiful chaos on the terrace. It is about the invisible thread that connects a ten-year-old's excitement to an sixtyfive-year-old's wisdom. So, here is to the physicists on the rooftops. Here is to the grandfathers. And here is to the sky that is big enough for all of us. Kai Po Che! t

# Lessons in Management from the Mahabharata

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The Mahabharata is often viewed as an ancient epic of war and dharma, but beneath the surface of the Kurukshetra battlefield lies a masterclass in organizational behaviour, leadership, and resource management. For a modern management student, the conflict between the Pandavas and the Kauravas offers profound insights into how a smaller, well-managed team can overcome a massive, disorganized corporation.

1. Strategic Alliances and Resource Optimization One of the most significant management lessons comes from the choice made by Arjuna and Duryodhana before the war. Duryodhana chose the vast Narayani Sena (the physical resource), while Arjuna chose Lord Krishna (the strategic counsel). Management Insight: In any project, the quality of leadership and strategic direction is more valuable than the sheer quantity of manpower. Sustainability of Science: Effective management ensures the sustainability of human capital by placing the right person in the right role, reducing burnout and wasted effort.

2. Comparative Management Styles To understand why the Pandavas succeeded despite being outnumbered, we can compare their organizational strategies with those of the Kauravas: Feature | Pandavas (Efficient Management) | Kauravas (Bureaucratic Management) Leadership | Shared Leadership: Each brother had a specific role based on their strengths. | Centralized Command: Heavy reliance on a single commander-in-chief at a time. Strategy | Strategic Mentorship guided by Krishna. | Resource Dominance and focus on army size. Structure | Flat organization with trust and quick decision-making. | Rigid hierarchy with internal conflicts. Goal | Shared vision aligned with Dharma. | Ego-driven objectives focused on power.

3. Leadership and Team Coordination Effective leadership and team coordination were evident in how the Pandavas managed their seven divisions against the Kauravas' eleven. The Vision: Krishna acted as the ultimate mentor, ensuring morale and alignment with the goal. Communication: Regular strategy sessions demonstrate the importance of communication in complex missions.

4. Risk Management and Ethics The fall of the Kauravas is tied to poor risk management and unethical decisions. Ignoring long-term risks for short-term gains ultimately weakened their organization. Modern management recognizes ethics as essential for sustainable growth. Conclusion The Mahabharata teaches us that management is not just about numbers; it is about psychology, ethics, and shared goals. Ancient Indian literature provides timeless strategies to build resilient, ethical, and effective organizations.

# Colors, Chemistry, and Community: The Hidden Science of Holi

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Holi, the vibrant festival of colors, signifies the transition from winter to summer and is celebrated with great enthusiasm across Gujarat. Beyond its cultural and spiritual significance, Holi also holds scientific relevance connected to health, climate, and social well-being. Seasonal transitions often weaken immunity and increase susceptibility to allergies. The outdoor activities associated with Holi, such as movement, laughter, and play, enhance blood circulation and help strengthen the immune system. Celebrations conducted during the daytime also enable the body to absorb natural sunlight, aiding the production of Vitamin D, which is essential for bone health and immunity. Traditionally, Gujarat used natural colors derived from kesudo flowers, turmeric, and medicinal herbs. These substances possess antibacterial and cooling properties, making them ideal for the approaching summer while remaining safe for the skin and environmentally friendly. The ritual of Holika Dahan plays an important role in reducing harmful microbes and insects that thrive during seasonal changes. Moreover, social interaction, music, and dance during Holi reduce stress, elevate mood, and strengthen community bonds. Thus, Holi in Gujarat is not merely a festival of colors and joy but a scientifically meaningful tradition that promotes health, harmony, and overall well-being when celebrated responsibly.



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