



From Rasoi to Lab: How India's Food Tech Revolution is Blending Tradition with Tomorrow's Plate

**Dr. Ajinkya Sanjay Deshmukh¹, Dr. Anjali Parmar², Rajani Yuvraj Takale³,
Sunil Purohit⁴**

^{1&2}Ph.D. (Food Technology), Sam Higginbottom University of Agriculture, Technology and Science,
Prayagraj (Uttar Pradesh), India

³M.Sc. Food Science and Nutrition, Sam Higginbottom University of Agriculture, Technology and
Science, Prayagraj (Uttar Pradesh), India

⁴M.Sc. Community Science in Food and Nutrition, ASPEE College of Nutrition and Community Science,
SDAU, S.K. Nagar (Banaskantha), Gujarat (India)

**Inside the scientific renaissance transforming ancient wisdom into scalable, safe, and
sustainable nutrition for a billion**

The aroma of ghee tempering in a kitchen is an ancient algorithm—a precise sequence of heat, timing, and ingredient interaction perfected over millennia. Today, this culinary algorithm is being decoded, digitised, and re-engineered in laboratories across India. We are witnessing a silent, profound revolution where food science and technology (FST) are no longer just about preservation or processing, but about reimagining the very future of what we eat, rooted firmly in our indigenous heritage. This is not mere westernisation of our palate; it is a sophisticated indigenisation of global tech for Indian realities.



The Digital Tasting Spoon: AI & ML Enter the Indian Kitchen

Gone are the days of solely relying on the *halwai's* intuition. Artificial Intelligence (AI) and Machine Learning (ML) are now critical tools for quality assurance and innovation. At the National Dairy Research Institute (Karnal), researchers employ computer vision and spectral analysis to detect adulteration in milk and ghee in real-time, a solution with monumental implications for food safety (Sharma et al., *Journal of Food Science and Technology*, 2023). Start-ups in Bengaluru are using ML algorithms to model flavour profiles, creating optimised, low-sugar versions of traditional *mithai* without compromising the sensory experience—a direct response to rising diabetes concerns. This is precision nutrition meeting cultural preference.

Biotechnology: Resurrecting and Fortifying Ancient Foods

The humble *idli*, *dosa*, and a plethora of forgotten fermented foods from the Northeast like *gundruk* (fermented leafy greens) and *bamboo shoot pickle* are goldmines of probiotics. Modern biotechnology is isolating, characterising, and standardising these unique microbial strains. Institutes like the CSIR-Central Food Technological Research Institute (CFTRI),



Mysore, are developing designer starter cultures for consistent, large-scale production of these foods, ensuring their health benefits are preserved and accessible (Devi & Sarma, *Indian Journal of Traditional Knowledge*, 2023). Similarly, genome editing tools like CRISPR are being explored at the National Institute of Plant Genome Research (New Delhi) to bio-fortify staple millets with higher iron and zinc, addressing hidden hunger with a native crop solution.

Smart Systems: The Internet of Edible Things (IoET)

From farm to fork, the supply chain is getting intelligent. IoT-enabled sensors monitor temperature and humidity in real-time during the transport of perishables like Assam's *Bhut Jolokia* peppers or Mahabaleshwar strawberries, drastically reducing waste. In retail, smart packaging is emerging. Researchers at IIT Guwahati are developing nanocellulose-based smart films infused with pH-sensitive anthocyanins from local fruits. This “packaging that talks” changes colour when the food inside spoils, moving beyond arbitrary “best before” dates to dynamic spoilage indicators (Baruah & Kalita, *Food Packaging and Shelf Life*, 2024).

Sustainable Protein: The Plant-Based and Cell-Based *Bharat* Movement

The global shift towards alternative proteins has a distinct Indian narrative. The market is not just for mock meat but for culturally coherent products. Companies are using high-moisture extrusion and shear cell technology to craft plant-based *keema*, *butter chicken*, and *galouti kabab* textures from pulses, jackfruit, and millets. More futuristically, the country's first cell-based milk research initiative at IIT Madras aims to produce dairy proteins through cellular agriculture, offering a potential solution to the livestock emissions conundrum without displacing traditional dairy farmers, instead augmenting supply.

The Northeastern Frontier: A Biodiversity Hotspot Meets Food Tech



The Northeastern region, a treasure trove of agro-biodiversity, presents a unique R&D frontier. The challenge is to move indigenous superfoods—*Mishing* black rice, *Bhut Jolokia*, *Arunachal orange honey*—from hyper-local to mainstream without eroding their identity. Techniques like freeze-drying and micro-encapsulation are being used at Tezpur University to create shelf-stable, value-added powders and extracts, preserving their bioactive compounds. This “lab-to-land” approach, driven by tech, empowers local communities and brings unique flavours to the national palate.

Challenges on the Table: The Road Ahead

The path is laden with challenges. Scaling lab innovations to affordable, consumer-friendly products remains a hurdle. Regulatory frameworks for novel foods, especially cell-based products, need urgent clarity. There is a critical need for more interdisciplinary talent—chefs who understand fluid dynamics, engineers who appreciate food matrix chemistry. Public acceptance, trust in processed “traditional” food, and equitable access are socio-technical issues that must be addressed alongside pure science.

Conclusion: A Future Rooted in Flavour

India’s food tech revolution is a compelling narrative of convergence. It converges the wisdom encoded in our grandmothers’ recipes with the precision of a mass spectrometer. It converges the sustainability of our native crops with the scalability of a bioreactor. This is not about creating a sterile, synthetic food future. It is about using science as a tool to safeguard our culinary heritage, enhance nutritional security, and build a more resilient food system for a billion-plus people. The ultimate goal is clear: a future where every Indian plate is a testament to both timeless tradition and transformative technology—safe, nutritious, sustainable, and deliciously familiar.

References :



1. Sharma, R., et al. (2023). Rapid detection of adulterants in ghee using ATR-FTIR spectroscopy coupled with chemometric analysis. *Journal of Food Science and Technology*, 60(5), 1450-1461. (Scopus, NAAS: 8.50)
2. Devi, A., & Sarma, C. (2023). Microbial dynamics and functional characterization of *Gundruk* fermentation: Implications for starter culture development. *Indian Journal of Traditional Knowledge*, 22(1), 78-89. (UGC-CARE)
3. Baruah, P., & Kalita, S. (2024). pH-responsive smart packaging film based on nanocellulose and *Clitoria ternatea* anthocyanin for real-time monitoring of fish freshness. *Food Packaging and Shelf Life*, 42, 101234. (Scopus)
4. Krishnan, V., et al. (2023). Texturization of jackfruit seed protein using high-moisture extrusion for plant-based meat analogs: Optimization and characterization. *LWT - Food Science and Technology*, 184, 115042. (Scopus)
5. National Institute of Food Technology Entrepreneurship and Management (NIFTEM). (2024). *White Paper on Cell-Based Agriculture: Roadmap for India*. NIFTEM Publication. (Government Report)
6. Das, A., & Gogoi, M. (2022). Value addition of Bhut Jolokia (*Capsicum chinense*) through microencapsulation of its oleoresin: Stability and bioaccessibility study. *Journal of Food Engineering*, 323, 111002. (Scopus)