

Development of betalain rich edible eco-friendly colorant from *Opuntia ficus-indica*

TECHNOLOGY AVAILABLE FOR TRANSFER

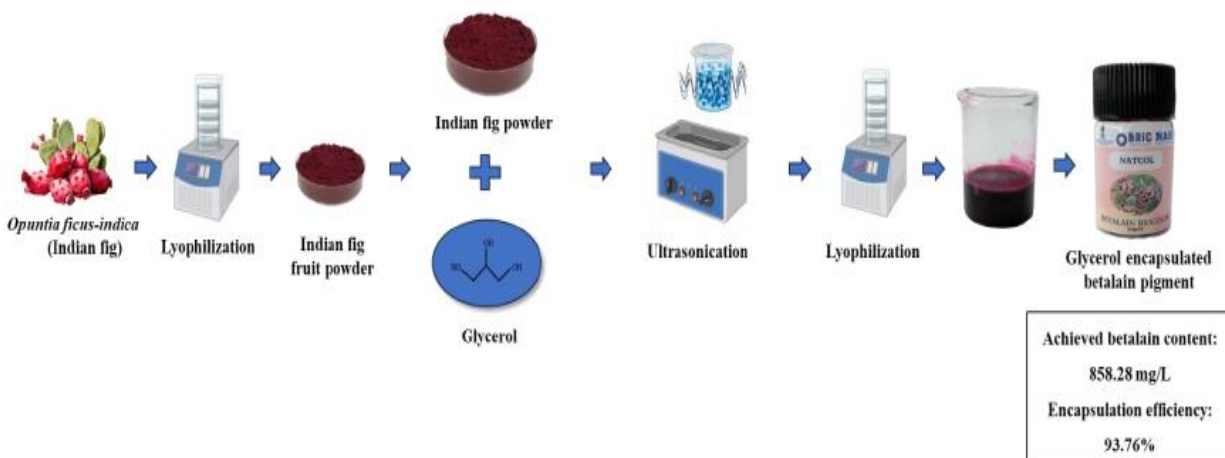
UNMET NEED AND OPPORTUNITY

Synthetic dyes like Red-40 and Yellow-5 are widely used for their bright and stable colors but are linked to health issues such as allergies, hyperactivity in children and possible cancer risks. This has increased the demand for safer, natural color alternatives. Plant-based pigments, specially betalains, show great potential as natural colorants because of their vibrant color, water solubility and health benefits. However, most natural pigments, including betalains, are unstable when exposed to heat, light, or changes in pH, which limits their commercial use. Conventional extraction methods like Soxhlet or solvent-based extraction (using ethanol or methanol) are inefficient, toxic, time-consuming and often degrade the pigments due to oxidation, hydrolysis or heat, making them unsuitable for food-grade use.

Therefore, there is a growing need for a solvent-free, eco-friendly, and stable natural colorant suitable for food and nutraceutical application, with improved betalain stability and shelf life.

TECHNOLOGY

The technology offers a clean, organic solvent-free method to produce food-grade betalain-rich color from Indian fig fruit (*Opuntia ficus-indica*). It uses Ultrasound Assisted Extraction (UAE) with glycerol instead of harmful solvents. The process is optimized by Response Surface Methodology and Box-Behnken Design and includes encapsulation steps to improve stability. The extracted color is characterized for its pigment content (betacyanin and betaxanthin), thermal stability, shelf-life, *in-vitro* digestibility and biological safety (non-toxic and anti-inflammatory). When used in food products like functional gummies, the color shows excellent appearance and consumer acceptance, comparable to synthetic dyes. Overall, this method produces a stable, safe, and bioavailable natural color suitable for food and pharmaceutical applications.











STAGE OF DEVELOPMENT

The technology is currently placed at TRL-4, has been developed and validated at lab scale using multiple analytical tools. Laboratory scale optimization of extraction and encapsulation parameters have been completed.



Biotech Consortium India Limited

NOVEL CHARACTERISTICS

	Eco-friendly and solvent-free: The process avoids harmful solvents by using water-based glycerol and ultrasound, making it safe, biodegradable, and eco-friendly.
	Better color stability and long shelf life: The dye is stable against heat, light and pH changes, lasting over 400 days under refrigerated, light-protected conditions, substantially higher than conventional colorants.
	High yield and bio-accessibility: Optimized extraction gives a high dye yield (up to 858 mg/L) and 94% efficiency, while improving bio-accessibility two-fold compared to traditional extraction methods.
	Safe and food-grade: The color is non-toxic, biodegradable, and safe for ingestion with proven cytotoxicity and anti-inflammatory safety tests, making it suitable for food, nutraceutical, and pharmaceutical products.
	Superior sensory performance: Demonstrated visual and sensory acceptance comparable to synthetic dyes (e.g. Carmoisine) when applied in gummies without altering taste or texture, offering a natural replacement for synthetic colors.
	Cost-effective and scalable: Uses a low-cost, drought-tolerant Indian fig, making the process economical and easily scalable for commercial production.
	User-friendly process: Simple to produce, non-toxic, and biocompatible.
	Sustainable: Uses Indian fig fruits, promoting eco-friendly and circular economy practices.



APPLICATION

- **Functional Food and Beverage:** Used as a natural color and antioxidant in gummies, smoothies, yogurts, and drinks.
- **Pharmaceutical and Nutraceutical:** Acts as a bioactive color and antioxidant in capsules, syrups, tablets, and herbal products, serving as a natural and functional ingredient.
- **Cosmetics and Personal Care:** Used as an eco-friendly pigment in lip balms, tinted creams, face masks, and bath products for natural coloring and sustainability.

INTELLECTUAL PROPERTY

Indian patent filed

LICENSING OPPORTUNITY

BCIL is looking for suitable Licensee for transfer of this technology.

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