CSIR-Central Salt & Marine Chemicals Research Institute

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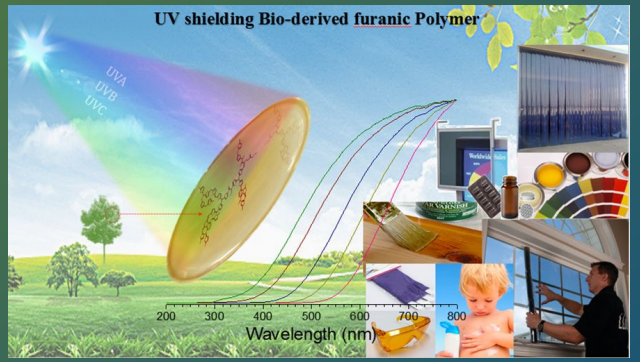
Technology Match Maker | Sustainable Ingredients for Skin & Personal Care | 12 Oct 2023

Bio-Derived Furanic Polymers As Skin-Friendly Sunscreen



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Organization: CSIR-CSMCRI
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Bio-Derived UV Shielders

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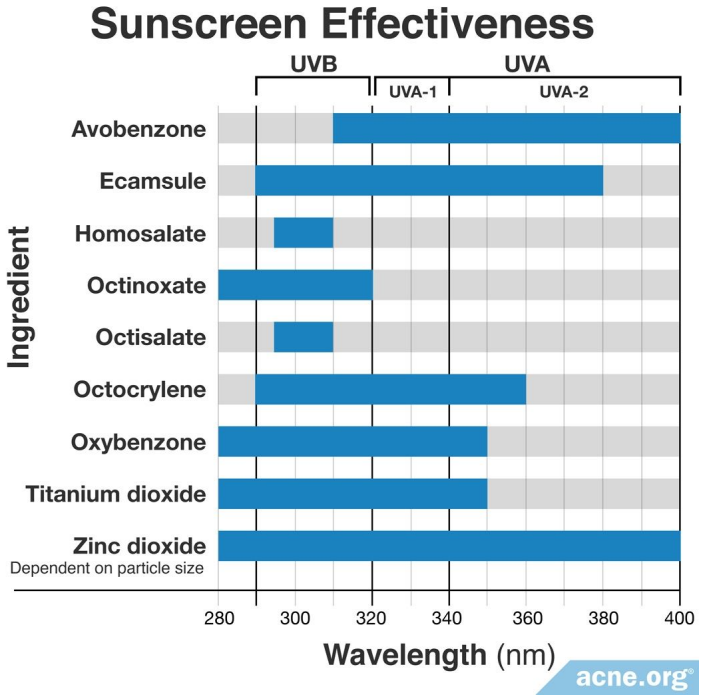
- UV shielders are agents that provide protection to skin and hair by blocking, deflecting or reflecting harmful ultraviolet (UV) radiation from the sun.



- UV rays are classified into three primary types based on their wavelength namely

UVC	UVB	UVA
200-290 nm	290-320 nm	320-400 nm

- While UV rays stimulate Vit D production in our body, prolonged exposure can cause health risks to our skin:
  - Need to protect skin from harmful effects of UV rays.

- Recent trend in biomass-derived materials for UV shielders spurred interest in exploring **bio-derived furanic polymers (BFP)**.

Opportunity for BFP as UV Shielder

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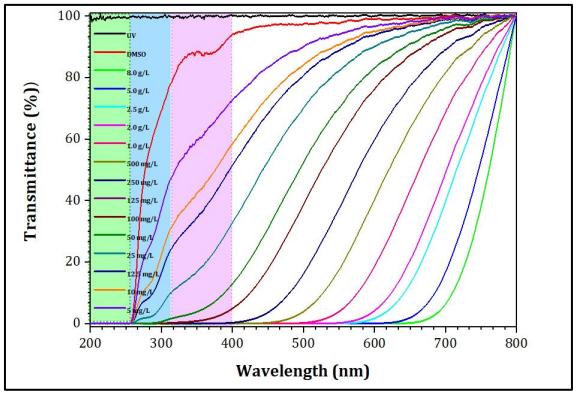
Transmittance spectra of BFP at various concentrations in DMSO



BFP has broad spectrum UV shielding (200-400 nm) ability at concentrations of 125 to 250 mg in 1L DMSO.

The global sun care products market size was valued at USD 13.97B in 2022 and is expected to expand at a CAGR of 4.5% reaching USD 19.65B by 2030[1].

Global market for sun protection active Ingredients valued at USD 0.8B in 2023 and estimated to reach USD 1.37B in 2033 growing at CAGR 5.3%[2].

Desired characteristics for UV shielders[3]:

- ➔ Ability to block the entire UV spectrum (200-400 nm).
- ➔ Photostability of product.
- ➔ Sensory characteristics including texture and colour of material for ease of incorporation in varied range of cosmetic and skin care formulations.
- ➔ Biodegradability of the material.

Comparing BFP And Approved UV Shielders

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Biomass-derived Furanic Polymer		Oxybenzone	Ecamsule	TiO_2	ZnO
Wide Range UV Protection	**UVC, UVB, UVA1 and UVA2 (200-400 nm)**	UVB and UVA1 (280-350 nm)	UVB, UVA1 and UVA2 partly (290-380 nm)	UVB and UVA1 (280-350 nm)	**UVC, UVB, UVA1 and UVA2 (200-400 nm)**
Lower Conc Required	**1%-2%**	1%-6%[1]	<10%[2]	2%-30%[3]	1%-25%[4]
Price Range[5]	**Estimated cost Rs. 135/Kg**	Rs. 1500/Kg	Rs. 887/Kg	Rs. 200-280/Kg	Rs. 175-235/ Kg
Stability	**Photostable**	Stable over 24 hrs[6]	Photo-unstable[6]	**Photostable**[7]	Stable upto 2 hrs[8]
Mode of UV Protection	Chemical filter	Chemical filter	Chemical filter	Physical filter	Physical filter
Type of Ingredient	Biomass-derived organic compound	Organic compound	Organic compound	Inorganic compound	Inorganic compound

Who Should Be Interested?

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Who?	Why?
Manufacturers of Skin Care, Personal Care, and Cosmetic products	• New value proposition for customers • Competitive edge
Manufacturers of chemical UV filters and bio-based ingredients	• New products and forays into new segments • Opportunity to expand into new markets
Manufacturers of 5-Hydroxymethylfurfural (5-HMF)	• New value added material from by-product • Opportunity to expand into new markets
Manufacturer of Paints and coatings	• New products and forays into new segments • Opportunity to disrupt the market
Manufacturers of Plastics and plastic additives	• New products and forays into new segments • Opportunity to disrupt the market

About Biomass-derived Furanic Polymers

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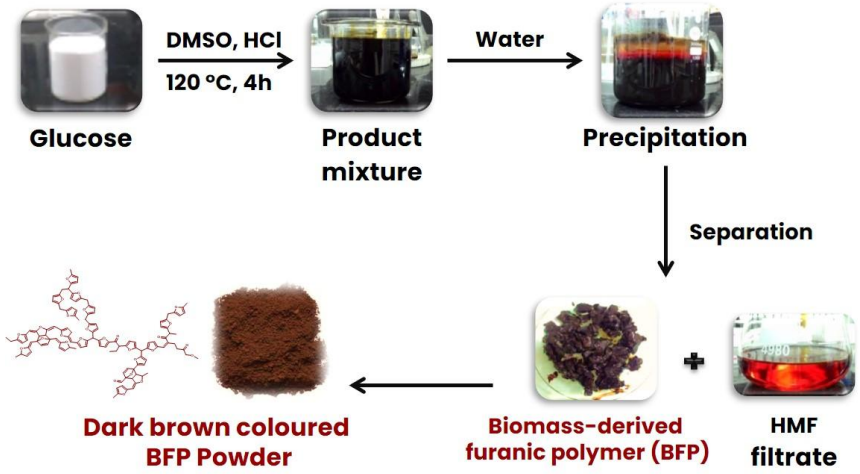
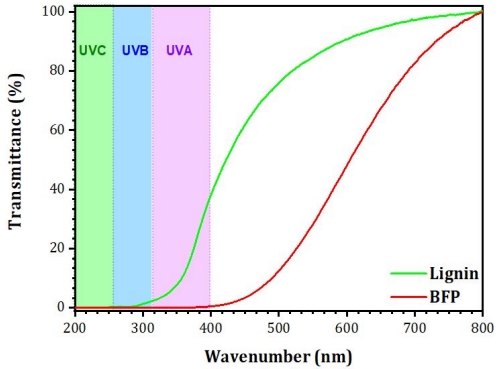
Process features:

- ➔ **Novel biomass-derived furanic polymers:**
  - ◆ **Value added product** derived from humin-like by-products during synthesis of 5-HMF.
  - ◆ **Sustainable and low cost carbon source:** glucose as starting material.
  - ◆ **Lower operating cost**: process uses heterogeneous catalyst.
  - ◆ **No heavy metal contaminations**.

Product features:

- ➔ **Highly conjugated polymer moiety,** with chemical structure and properties comparable to Lignin.
- ➔ **UV shielding range:** Broad Spectrum
- ➔ **Expected yield:** 14-20%
- ➔ **Biodegradable:** As per OECD 301D, BFP degrades by 60% in two weeks and shows superior degradability than Lignin.





Transmittance spectra of BFP (1g/l DMSO) and Lignin (1g/l DMSO) at optical transparency 700 nm

BFP showed better UV shielding efficiency than Lignin

BFP Loaded Composite Thin Films

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BFP loaded (1.5-2%) PVA composite thin films prepared via solvent evaporation method exhibited:

- ➔ Broad Spectrum UV Shielding
- ➔ Photostability and thermal stability in Xenon accelerated test (ASTM G155 and IS2553).
- ➔ High mechanical durability

SPF based on UV standard 801:

$SPF = \sum_{200}^{400} E_\lambda S_\lambda / \sum_{200}^{400} E_\lambda S_\lambda T_\lambda$

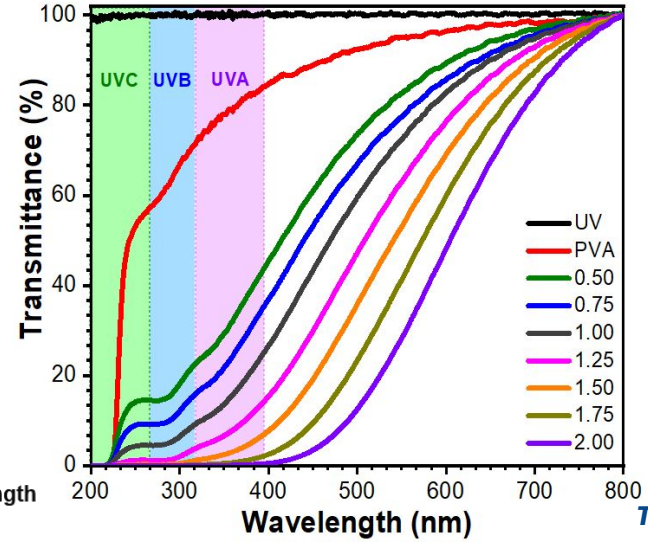
E_λ = erythema spectral effectiveness;
T_λ = spectral transmittance of sample films;
S_λ = solar spectral irradiance; and λ = wavelength

Sun Protection Factor (SPF)

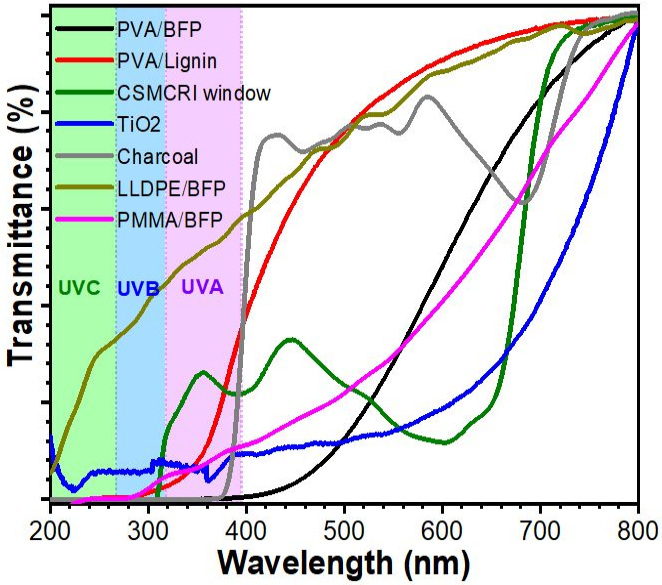
(Wt%) BFP-PVA thin film	T(UVB) Avg (%)	SPF ratings	SPF category
0.75	13.10	<10	Good
1.00	7.16	<15	Good
1.50	0.65	45	Very good
2.00	0.00	>50	Excellent

BFP loaded with other UV stable polymers showed significant UV shielding when compared to commercial sunscreens

Transmittance spectra of BFP loaded PVA thin films at optical transparency at 700 nm



Transmittance spectra of BFP loaded polymeric thin films and other sunscreens at optical transparency at 700 nm



BFP UV Shielding Potential In Formulations

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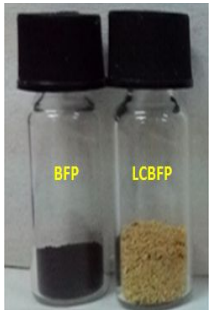
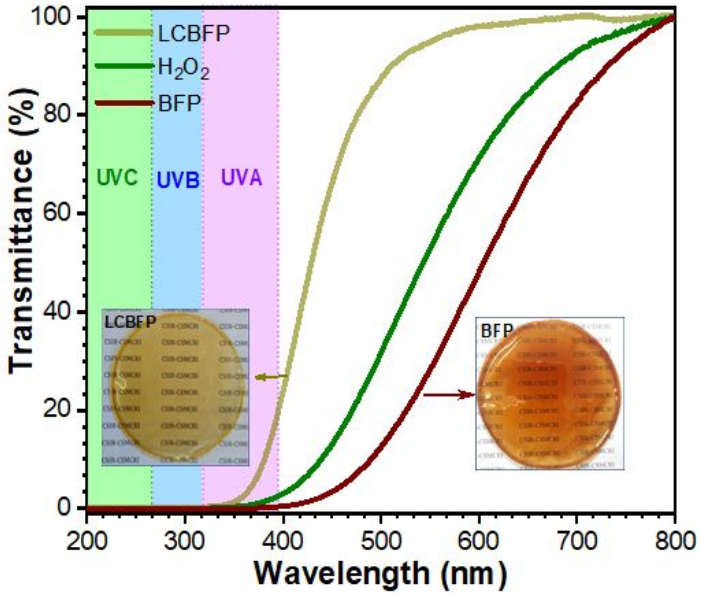
Enhanced sensory characteristics: Decolorised BFP exhibited better optical transparency and retained UV shielding ability of SPF50.

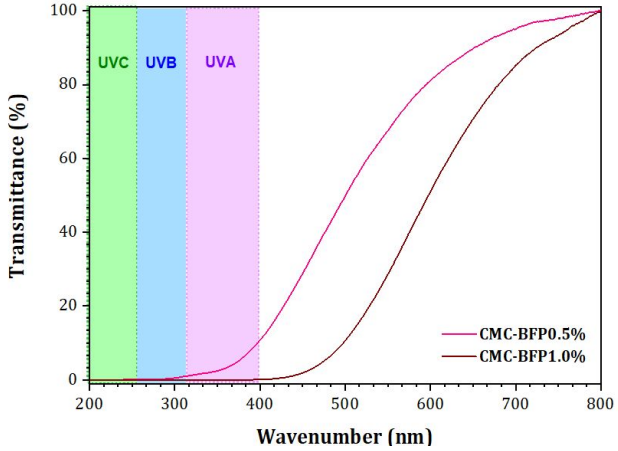
Dark brown colour of BFP could be reduced by a one-step method of irradiating it with UV in THF solution.





Transmittance spectra of BFP & decolourised BFP loaded (at 2%) PVA thin films at optical transparency 700 nm

Transmittance spectra of BFP loaded (0.5% and 1%) in Carboxymethyl Cellulose (CMC)



BFP loaded at (0.5% to 1%) in Carboxymethyl Cellulose (CMC) showed significant UV shielding indicating potential performance in sunscreen formulations. CMC is used as cosmetic thickener and stabiliser.

Current Status

Technology Status:

- **Demonstrated at Lab Scale**

IP Status:

- **Patent filed: UV shielding bio-derived furanic polymers.**

Patents:

- ★ Priority Date: 01.02.2018
- ★ Coverage: India, USA, Europe, Australia, Singapore
- ★ Status: Granted in India, USA, Australia,

Publications:

- ★ ACS Appl. Polym. Mater. 2021, 3, 4, 1932–1942.

Reduced BFP colour

BFP | LCBFP | BFP-H2O2

Team & Organisation

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Lead Scientist:
Dr. Kannan Srinivasan

- ★ **Director**, CSIR -CSMCRI, Bhavanagar.
- ★ **Awards & Honors:** Humboldt Fellow (Germany), JSPS-INSA Research Fellow (Japan), Raman Research Fellow (USA), CRSI Bronze Medal
- ★ **Expertise:** Heterogeneous catalysis; Environmental chemistry; Material science; Solid state chemistry.

★ **Central Salt and Marine Chemicals Research Institute (CSMCRI)** is a constituent lab of the CSIR, India, with a track record of successful technology transfer & working with industry having attractive models of engagement and flexible terms for IP.

★ **Key assets and strengths of Dr Srinivasan lab:**

- 4 granted, 1 filed US patent; 25 publications in biomass value addition.
- **Team strength:** 6
- **Well equipped labs and analytical facilities:**
  - Excl high pressure reactor lab; reactors capacity from 50 cc to 10 L with different MoC
  - State-of-art, sophisticated analytical infrastructure facility
  - XPS (X-ray photoelectron spectrometer) for surface characterization of solid catalysts.
  - Pilot plant facility
- **Industry Sponsored projects** like biomass derived chemicals for Jayant Agro.

JAYANT AGRO-ORGANICS LTD.

Next Steps

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- The team has developed the background science and demonstrated lab scale processes as a proof of concept.
- The team has expertise as to how the process can be modified to get desired products.
- The next phase will be to work closely with industry partners to:
  - Product safety and sun protection tests as per established guidelines.
  - Scale-up and optimise process.
  - Define techno commercial specifications for the product.

Seeking:

- **Industrial partners interested in technology licensing.**
- **Industrial partners interested in sponsoring further technology advancement and scale up.**
- **Industrial partners interested in raising 3rd party funds for a collaborative project.**
- **Industry interested in tapping scientist capabilities as an expert/ consultant.**

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For More Information Contact:

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References

- Slide 1 - Image: ACS Appl. Polym. Mater. 2021, 3, 4, 1932–1942.
- Slide 2 - Image: https://www.acne.org/whats-the-difference-between-uva-and-uvb-rays
- Slide 3 - [1] https://www.fortunebusinessinsights.com/sun-care-products-market-103821
- Slide 3 - [2] https://www.factmr.com/report/sun-protection-active-ingredient-market
- Slide 3 - [3] https://www.cosmeticsdesign-europe.com/Article/2021/09/02/
- Slide 4 - [1] https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=352.50
- Slide 4 - [2] https://www.federalregister.gov/documents/2015/02/25/2015-03883/
- Slide 4 - [3] https://pubs.acs.org/doi/10.1021/acsomega.6b00177
- Slide 4 - [4] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8550398/
- Slide 4 - [5] https://www.indiamart.com/ (access date: 7th October 2023)
- Slide 4 - [6] https://www.sciencedirect.com/science/article/abs/pii/S1010603016301769
- Slide 4 - [7] https://www.intechopen.com/chapters/55103
- Slide 4 - [8] https://www.azom.com/news.aspx?newsID=56971
- Slide 10 - https://www.csmcri.res.in/Dr-Kannan_Srinivasan