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Tech Transfer Hub

Match Maker/ Sustainable Ingredients/ 3 Feb 2023

Industrial production of Shikonin and its derivatives for food colorants

Lead Inventor: Dr Shashi Bhushan

Organization: CSIR-IHBT, Palampur

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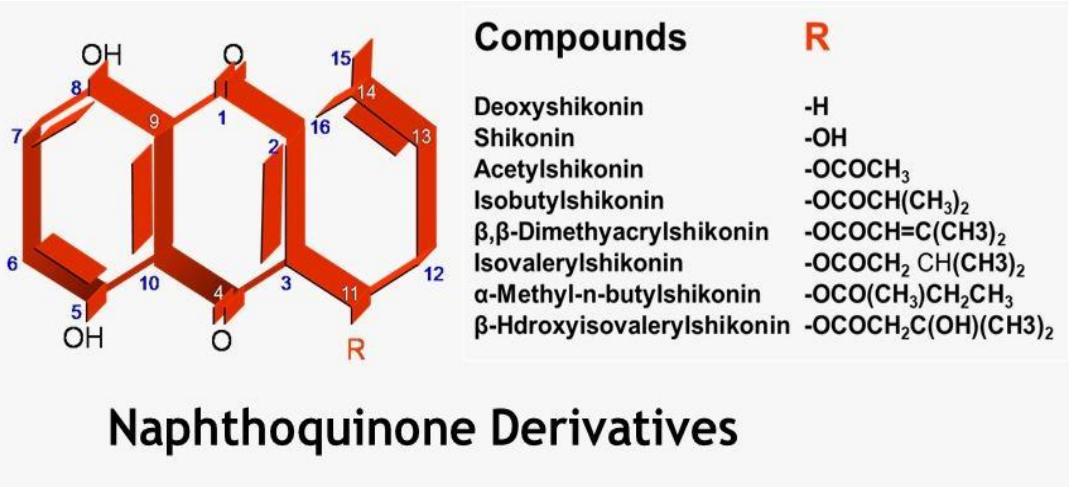
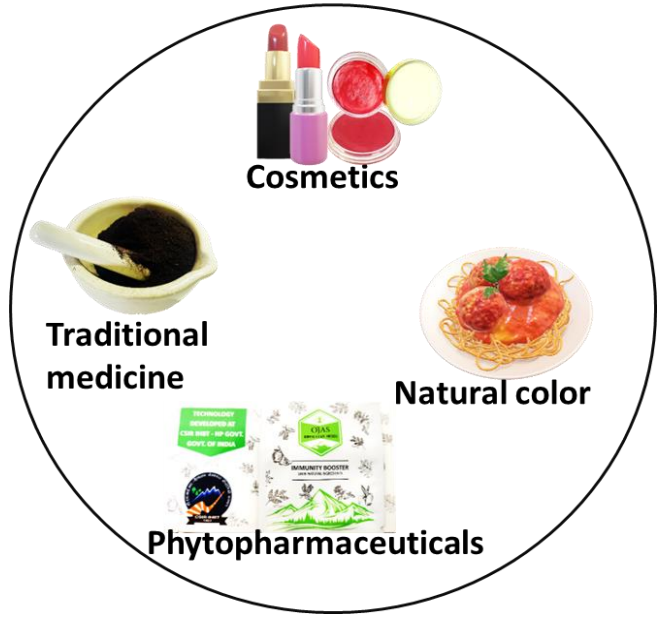
Shikonin derivatives are used as colorants





Types of products available in the market

Root extract powder

Root powder

Dominant Shikonin is Deoxyshikonin in the products.

The Opportunity

The global natural food colorants market size was valued at **USD ~2 billion in 2021**. It is expected to reach **USD ~4 billion by 2030**, growing at a **CAGR of 9.31%** during the forecast period (2022–2030).

1) Increased demand for natural pigments in food and personal care products with desire to limit excessive usage of synthetic food colours.
2) Offers phytopharmaceutical properties: Anti-inflammatory, wound healing, antic cancerous, antidiabetic, skin protection and provide nourishment (creams and shampoos)
3) Textile and printing dye

- Major global suppliers of natural food colorants: Chr Hansen Holdings A/c, Symrise AG, FMC Corporation, DDW, The Color House, Sensient Colors LLP, LycoRed Ltd.

Source: Straits research, 2023; https://straitsresearch.com/report/natural-food-colorants-market

The Opportunity

- Shikonin-based compositions (henceforth called **shikonin+**) are FSSAI approved food colourants and are popular red coloring agent, mainly used in juice drinks, ice cream, popsicles, fruit wine, cheese and spices etc. It can also be used for cosmetics, detergents, dyes and pharmaceuticals.
- Shikonin+ are produced primarily from natural sources. We are not aware of any synthetic approaches.
  - Major production is from the plants:
    a) Gromwell/ *Lithospermum erythrorhizon*
    b) Ratanjot / *Arnebia euchroma*
- Premium price product:
  - Root powder > Rs 3000/kg
  - Root extract > $ 20-200 /kg (Rs 1600-16000/ kg)
- Major global suppliers of Shikonin: Yangling Ciyuan Biotech, Shaanxi Jintai Biological Engineering, Xi'an Lyphar Biotech, Lisi (Xian) Bio-Tech, Xian Aladdin Biological Technology, Xian Sost Biotech, Xi'an DN Biology

About the technology

Technology features:

- **Sustainable**: *In vitro* adventitious root culture of *A. euchroma* as a sustainable source of natural pigment rather than uprooting plants from natural habitat.
- **Year around availability**: Compared to seasonal (April-September) availability in wild, the *in vitro* system can provide year round production.
- **Shorter production cycle**: The cultivation cycle of adventitious roots is 5 weeks compared to 3-4 years in wild.
- **Productivity**: Higher pigment accumulation (3 times to wild collected plants)

Samples	Naphthoquinone pigments (mg/g DW)			Total pigment
	Shikonin	Deoxyshikonin	β, β-dimethylacrylshikonin	
Adventitious roots (AR) based on current tissue culture technology	Not quantifiable	14.876±0.012 [a]	0.896±0.003 [b]	15.770±0.010 [a]
Wild sourced root powder procured from market	0.354±0.004 [a]	0.596±0.003 [c]	9.210±0.012 [a]	10.66±0.012 [b]
Roots of mother plant (collected from wild) used for raising AR (3-4 yr old)	0.193±0.001 [b]	3.843±0.009 [b]	0.676±0.003 [c]	4.71±0.008 [c]

- **Natural**: No genetic modification, like hairy roots where *Agrobacterium rhizogenes* used for induction

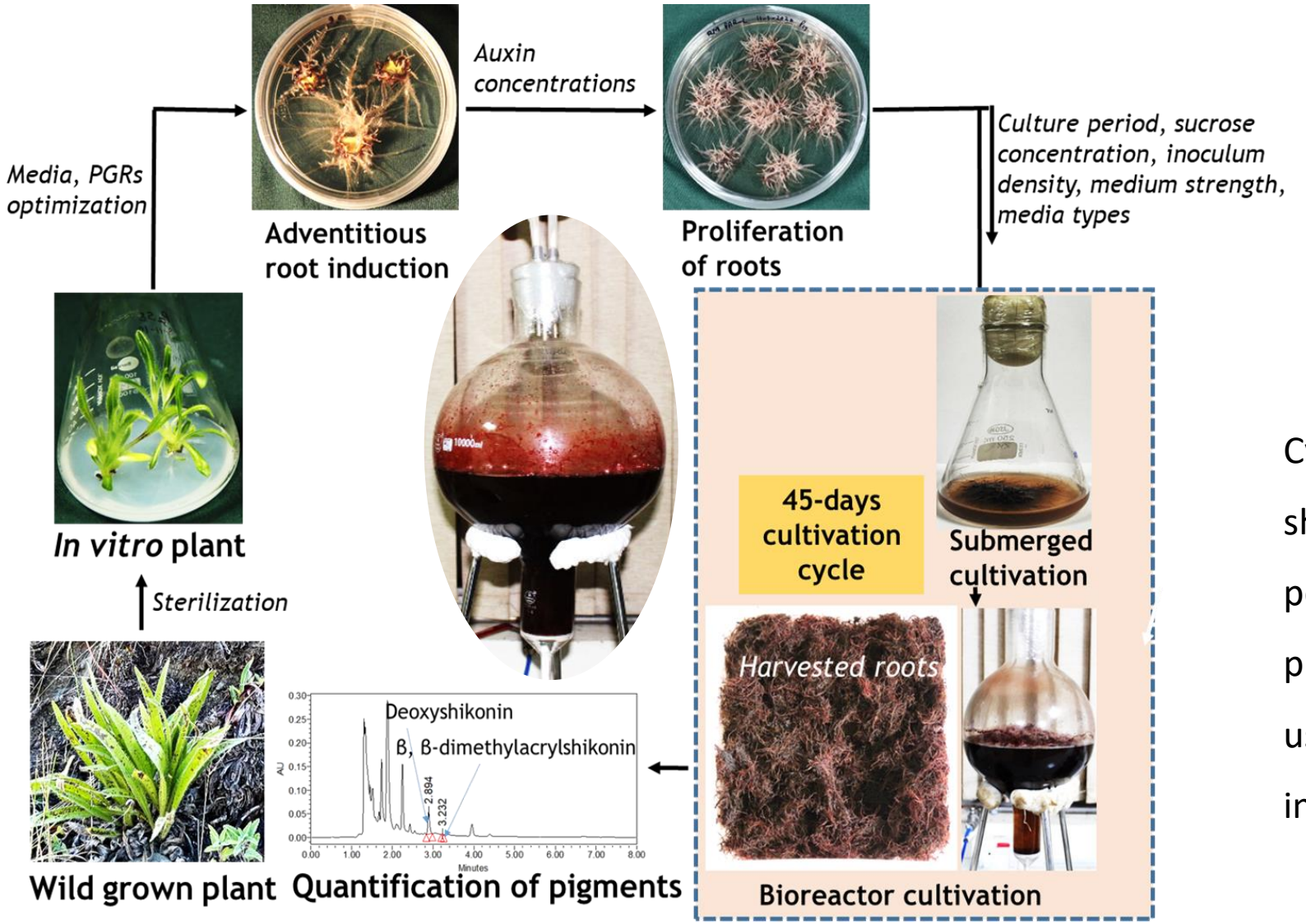
Product features:

- **Sustainable technology**: Conserving natural resources as no dependency on wild collected material
- **Stable batch wise chemical profile**: Consistent quality with marker compounds like Deoxyshikonin and *β*, *β*-dimethylacrylshikonin

Lithospermum and *Arnebia* are both:

a) endangered species
b) seasonal
c) grown only in the wild

We have developed a plant-tissue culture process to generate adventitious roots for production of Shikonin+



Safety evaluation of the pigments

Cytotoxicity analysis for pigment extract showed that it is safe. Also, it is pertinent to mention that Arnebia pigments are FSSAI approved and being used as colourant in foods for centuries in Asian countries

Devi J, Kumar A, Kumar D, **Bhushan S** (2022). Adventitious root cultures of *Arnebia euchroma*: a sustainable alternative for the production of natural pigments. Ind. Crops Prod. 187: 115461

Who should be interested and why?

Who?	Why?
Food pigment suppliers	New products and forays into new markets
Food and personal care FMCG companies **Cosmetics** **Phytopharmaceuticals** **Textiles**	Sustainably sourced natural pigment
Shikonin suppliers	Sustainable way of large scale production

National Commitment: Sustainable Development Goal12 and 15 for 'sustainable pattern of consumption and production' and 'reduce, halt and reverse the loss of biodiversity'

Current status

Technology status:

❖ Demonstrated at lab scale (5 L bioreactor)

Patent filed vide Application No.: 202111045278; Priority date: 4-10-2021

INTELLECTUAL PROPERTY INDIA

Application Filing Receipt

Goverment of India
Patent Office
Intellectual Property Office Building,
Plot No. 32, Sector 14, Dwarka,
New Delhi-110075
Phone- 011-28032253, 25300200
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e-mail: delhi-patent@nic.in

CBR Number : 35248

CBR date: 04-10-2021

Application Type: ORDINARY APPLICATION
Priority Number:
Priority Date:
Priority Country: Not Selected

To,
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
Head, Innovation Protection Unit, NISCAIR Building, 3rd Floor, 14 Satsang Vihar Marg, New Delhi - 110067(t (IPU), CSIR

Received documents purporting be to an application for patent numbered 202111045278 dated 04-10-2021 by COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH of Anusandhan Bhawan, 2 Rafi Marg Rafi Marg New Delhi relating to A PROCESS FOR PRODUCTION OF NAPHTHOQUINONE RED PIGMENTS FROM ADVENTITIOUS ROOTS OF ARNEBIA EUCHROMA together with the and fee(s) of ₹8000 (Eight Thousand Rupees Only).

Note:

1. In case of Patent Application accompanied by a Provisional Specification, a complete Specification should be filed within 12 months from the date of filing of the Provisional Specification, failing which the application will be deemed to be abandoned under Section 9(3) of the Patent Act, 1970.
2. You may withdraw the application at any time before the grant of patent, if you with so. If, in addition to withdrawal, you also wish to prevent the publication of application in the Patent Office Journal, the application should be withdrawn within fifteen months from the date of priority of date of filing, whichever earlier.
3. If not withdrawn, your application will be published in the Patent Office Journal after eighteen months from the date of priority of date of filing, whichever is earlier.
4. If you with to get your application examined, you should file a request for examination in Form-18 within 48 months from the date of priority or date of filing, whichever is earlier, failing which the application will be treated as withdrawn by the applicant under Section 11(B)(4) of the Patent Act, 1970.

(For Controller of Patents)

Patent:

A process for production of naphthoquinone red pigments from adventitious roots of *Arnebia euchroma.*

Next Steps

Identify an industrial partner for technology transfer/co-development of the technology involving scale up to pre-commercial levels, carryout detailed process simulation and production trial

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
- Industries interested in tapping scientist capabilities as an expert/ consultant

Lead Scientist

CSIR- Institute of Himalayan Bioresource Technology (IHBT), Palampur (H.P.)

Dr. Shashi Bhushan,
Senior Principal Scientist
CSIR-IHBT, Palampur

- Over 15 years experience in Plant Cell and Tissue Culture Technology with production of phytochemicals in bioreactors
- Young Scientist Fellow, DST, GOI (2006)
- Nominated by National Productivity Council (2012), GOI for participation in a project, "**Value Addition to Agricultural Products for Greater Access to New Markets**" at Manilla, Philippines
- Awarded Raman Research Fellowship (2015-16) to work on **Industrial Scale Production of Phytochemicals in Bioreactor** at Cheongju, South Korea

Expertise: *In vitro* Plant Secondary Metabolite Production using Plant Tissue Culture Technology, Bioprocessing and Bioreactor Technology, Value Addition

About the Organization

CSIR- Institute of Himalayan Bioresource Technology (IHBT), Palampur (H.P.)

- CSIR-IHBT is situated at Palampur (H.P.) in the lap of western Himalayas with a vision **“to be a global leader on technologies for boosting bioeconomy through sustainable utilization of Himalayan bioresources”**.
- Key assets and strengths of the team:
  - ✔ Over 50 entrepreneurship and incubatees at the campus
  - ✔ Support to the society by providing agrotechnology for medicinal and aromatic plants, floriculture crops and value addition
  - ✔ As per SCIMAGO rating CSIR-IHBT ranks in 10th position among the CSIR labs
  - ✔ CSIR-IHBT is a member of the "Indian Himalayan Central Universities Consortium“ GoI
  - ✔ Technologies transfer: 32 technologies transferred to to 66 entrepreneurs by the institute in last five years
  - ✔ Member of Fund for Regeneration of Traditional Industries (SFURTI) under MSME

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VENTURE CENTER

The Opportunity

The global 1,4-Naphthoquinone market size is estimated to be worth USD million in 2021 and is forecast to a readjusted size of USD million by 2028 with a CAGR during review period. Pharmaceutical accounting of the 1,4-Naphthoquinone global market in 2021, is projected to value USD million by 2028, growing CAGR in next six years.

- Price: Rs 2,700 per 100 g (Otto Chemie Pvt Ltd), Used as a dye precursor.

- Major global suppliers: Tianjin CITIC Kaitai Chemical Co., Ltd., HBCChem, Yangzhou Jiedi Biological Technology Co., Ltd., Jin Jinle Chemical Co., Ltd., Alchem Pharmtech, Kawasaki Kasei Chemical, Shanghai Nuotai Chemical Co., Ltd., Hubei Xinrunde Chemical Co., Ltd., Weifang Tongrun Chemical Co., Ltd.

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