

TECHNOLOGY PROFILE

Vol. II



सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
CSIR-Institute of Himalayan Bioresource Technology
पालमपुर-176 061 (हि.प्र.) / Palampur-176 061 (H.P.)





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Preface

CSIR-Institute of Himalayan Bioresource Technology, Palampur, situated in the lap of Dhauladhar mountain range is a state of the art research institution with the mission to discover, develop and commercialize processes and products from Himalayan bioresources using cutting edge science and technology.

Understanding the importance of bio-wealth and the infinite possibilities to utilize them, CSIR-IHBT has consistently endeavoured to develop wide range of technologies catering to the needs of industry and common man, such as personal hygiene products, nutraceuticals, aromatics, textile fibres, natural colours and value added ready-to-eat foods. An initiative was taken to compile and publish the technologies developed at our institute for wider outreach. The first volume of the compendium consisting of 41 technologies was published in 2019.

Continuing the exercise, in this second volume, 35 new technologies developed at the institute have been compiled and categorized into four sections namely, biotechnology, agro-technology, food-technology and chemical-technology.

An effort has been made to keep the document informative and suitable for diverse audiences, as well as to stimulate scientific spirit among the readers. These technologies are relevant under the national missions such as Make in India, Swachh Bharat and Swasth Bharat. The institute is working towards entrepreneurship development through these technologies by working closely with micro, small and medium enterprises (MSMEs) and start-ups, and by incubating entrepreneurs in our facility for creating a self-reliant India (Atmanirbhar Bharat). We trust these technologies would fulfil the national mission and aspirations of common man.

We welcome constructive feedback from stake holders to improve our technologies and this compendium further.

Wishing you all a happy reading!

(Sanjay Kumar)



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BIOTECHNOLOGY



Simultaneous production of biodegradable bioplastic polyhydroxyalkanoates (PHA) and violacein pigment from Himalayan bacteria

Biodegradable plastics (bioplastics) from microorganisms are important eco-friendly alternative to petroleum based plastics. One of the major class of bioplastics derived from microorganisms are polyhydroxyalkanoates (PHA) with applications ranging from biomedical to commodity plastics and textile industries. PHAs are an important substrate for green economy and potential solution to plastics pollution. The global demand for bioplastics is ever increasing with a market value as of 2021 is USD 93.5 million and estimated to grow at 4.9% annually.

Considering the importance of the bioplastics, CSIR-IHBT has identified a unique Himalayan bacterium isolate PCH194 capable of synthesizing PHAs up to 70% of its dry cell weight. In addition, the bacterium simultaneously produces pigment violacein that finds application in textile, cosmetics and pharma industries. Violacein has been attributed with antioxidant, antitumoural, antibacterial, antiviral, and antiprotozoal activities.

CSIR-IHBT has developed a bioprocess for lab scale production and extraction of bioplastic and violacein pigment and aim to develop bioplastic blends for commodity applications in packaging, carry bags and coating applications.

The salient features of the process are

- Niche specific novel Himalayan bacterium isolate.
- Produces bioplastic up to 70% of its dry cell weight.
- Uses simple sugars as source of carbon
- Simultaneous production of bioplastic and valuable violacein pigment

Patent filed – number 0041NF2020



Process scale fermentation (23 L)

Biodegradable Bioplastic from High Altitude Bacteria



Bacterial strain

Extraction of bioplastic granules and bio-film formation

Tissue culture protocol for mass production of quality corms of saffron



Tissue culture protocol for production of saffron corms and their flowering in field conditions

Saffron (*Crocus sativus* L.), the most expensive spice on earth belongs to family, Iridaceae. It is popularly known as the 'Golden Condiment' or the 'Red Gold'. The spice is highly prized for its aroma, flavour and colour and has tremendous commercial value in the food, beverage and pharmaceutical industry. Although, saffron from Kashmir in India is considered to be of best quality, it accounts for only 3% of the global trade. A major constraint in large scale saffron cultivation is an acute scarcity of healthy disease free corms (planting material). In an effort to improve the availability of disease free corms, CSIR-IHBT developed a tissue culture protocol with following salient features

- Produces large number of disease-free and quality corms of saffron throughout the year.
- The method is a season independent process.
- The method is up-scalable and eliminates need for flowering sized corms as starting material

Patent under process

Mass production of *Nardostachys jatamansi* – a critically endangered high value medicinal plant of Himalaya

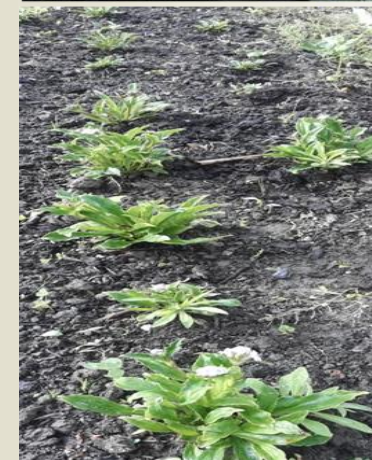
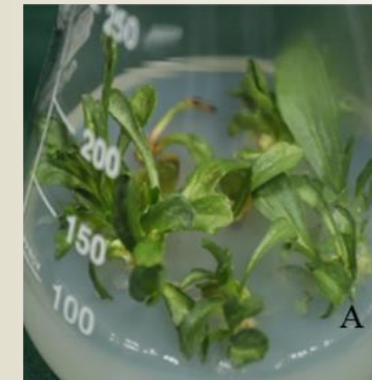
Nardostachys jatamansi (D.Don) DC., belonging to family, Caprifoliaceae is a critically endangered high value medicinal plant having restricted distribution in alpine and sub-alpine Himalayan regions (2200 to 4800 m amsl) of Bhutan, China, India, Nepal, and Tibet. The roots and rhizomes are rich in secondary metabolites. The plant is extensively used in alternative systems of medicine and herbal industry for the treatment of various ailments related to nervous, digestive, circulatory, respiratory, urinary and reproductive systems. Specifically, the plant is acclaimed for its nootropic and hair growth promoting properties.

The plant is amongst the top 10 highly traded plants having an annual trade of about 1000 metric tons and the 'Spikenard essential oils' has high market value.

Salient features of the protocol

- An efficient cost and time effective protocol for large scale production of the critically endangered plant.
- Tissue culture raised plants can be used by pharmaceutical, perfumery and cosmetics industry.
- The protocol is up-scalable.

Patent under process



Micropropagation of *N. jatamansi*
(A) shoot cultures
(B) Mass multiplication of the plant
(C) Field cultivation of *N. jatamansi*

Technology with short cultivation cycle for production of adventitious roots as a source of valepotriates



Valeriana jatamansi

Technology for production of adventitious roots from *Valeriana jatamansi* JONES, an threatened Himalayan medicinal and aromatic plant was developed as an alternate source of bioactive compounds. These roots contain valerenic acid and its derivatives that are used as tranquilizers in traditional as well as modern system of medicine around the world. Presently, it is solely collected from wild. Hence, the developed technology will also help in reducing the dependency on natural habitat.

Market potential

Annual demand for Valeriana root is approximately about 2000 MT

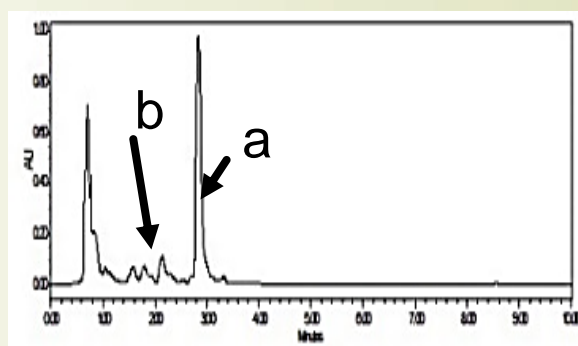
Salient features of the process are

- Sustainable process to generate *in vitro* adventitious root from *Valeriana jatamansi* independent of environmental and geographical barriers
- Short *in vitro* cultivation cycle (40 days) as compared to natural habitat (24 months)
- Novel metabolic profile owing to the presence of hydroxyvaleric acid

Patent applied



Induced adventitious roots



Bioactive compounds of adventitious roots (a) valerenic acid, (b) acetoxy valerenic acid

Technology for shortened flowering cycle and year round production of Lilium and Tulip

Hydroponics is a soil less cultivation technology that utilizes mineral salt solutions in specific proportions for continuous production of crops. The technology is ideal for seasonal crops, rare medicinal plants and for agriculturally unproductive lands. With increasing demand for urban, high tech agriculture, CSIR-IHBT developed hydroponic cultivation process for commercial cut-flower crops such as Lilium and tulip. The technology involves development of crop specific hydroponic nutrient recipe standardization for optimal growth of plants within a short span of time for getting access in off-season flower market.

Market Potential

Lilium and Tulip Market is estimated USD 2.5 billion and USD 4.4 billion

Salient Features of the technology

- Early flowering in Lilium (55 days) & in Tulip (30 days).
- Crop specific nutrient recipe for flower crops
- Year round flower production

CSIR-IHBT provides

- Training and skill development on hydroponic cultivation
- Consultancy for hydroponic projects

Patent applied



Lilium



Tulip

Technology for year round cultivation of quality spice crops



Basil



Oregano



Parsley

CSIR-IHBT has developed hydroponic cultivation process for spice crops such as Basil, Oregano and Parsley. These spice crops find application in daily culinary, extraction of active spice components and dehydrated food products. The demand for spice crops are increasing and currently valued at USD 8 billion and expected to grow at 12%.

Salient features of technology

- Crop specific nutrient media
- Short cultivation cycle
- Uniform quality produce
- Disease free plants
- Year round crop production

CSIR-IHBT provides

- Training and skill development on hydroponic cultivation
- Consultancy for hydroponic projects

Patent applied

Mass production of *Diplazium maximum*: A nutritious ethnic food of Himachal Pradesh

Diplazium maximum (D. Don) C. Chr., is an edible fern locally known as Khasrod or Lengadu belongs to family Athyraceae. The croziers or highly curled young fronds of the fern are consumed as a nutritious leafy vegetable and a seasonal delicacy. The young fronds are energy rich containing high amounts of minerals (iron and zinc), polyphenols, essential amino acids and polyunsaturated fatty acids (i.e., omega-3 and omega-6 including the unique dihomo- γ -linolenic acid). The fronds are also important source of protein and dietary fibre.

CSIR-IHBT has developed an efficient protocol for mass propagation of *Diplazium maximum*

Salient features of the tissue culture technology

- Low cost, time effective protocol for rapid multiplication of the fern
- Easily scalable protocol
- Eliminates dependency on natural plant population as raw material
- Potential resource of nutritionally enriched food products

Patent under process

Nutritional content of *D. maximum* per 100 gram

Parameters	Content
Energy	319.42 Kcal
Crude protein	25 g
Dietary fibre	38 g
Branched chain amino acids	3.58 g
Polyunsaturated fatty acids	0.85 g
Iron	2.05 mg
Zinc	0.46 mg



Fiddlehead



In vitro multiplication



Field cultivation

Compost booster for cold region

Compost booster



Composting process become inefficient under prolonged winters and extremely cold climatic conditions. The low temperatures limit the initial microbial load and hence pose technical challenges by extending the mesophilic phase and shortening the thermophilic stage. This delays drying of material and consequently product maturity. Overall, the limited microbial population on the onset of degradation, low temperature and moisture level, inefficient proteo-ligno-cellulolytic microbes renders composting process inefficient.

The global compost market is expected to reach an estimated USD 9.2 billion with a compounded annual growth rate of 6.8% by 2024. With increasing focus on organic farming in states adjoining the Himalayan range, the market potential for compost booster targeting the cold region is expected to be huge. In this context, CSIR-IHBT has developed a compost booster that can be applied to range of waste substrates such as kitchen waste, human/animal waste and agro residues.

The salient features of the product are

- Ready to use formulation
- Contains cold tolerant hydrolytic bacteria
- Supplemented with biofertilizer
- Bacteria encapsulated with effective carrier material
- Enhanced nitrogen fixing, phosphate solubilisation and potash mobilization properties
- Reduced foul odour during composting process
- Suitable for organic cultivation

Patent under process



AGROTECHNOLOGY



Lavender (*Lavandula officinalis*): agro- and processing technology

Lavender (*Lavandula officinalis* L.) is an aromatic crop of temperate region used in perfumery, cosmetic and pharmaceutical industry.

Market potential:

Global lavender oil market is expected to reach US\$ 864.7 Million with a compounded annual growth rate of 10.3% between 2020 and 2025.

Contribution of CSIR-IHBT:

- Improved agro and process technology
- Quality planting material
- Skill development programmes
- Introduction in Himachal Pradesh and Uttrakhand



Fresh flowers



Dry flowers



Essential oil

Rosemary (*Rosmarinus officinalis* L.): agro- and processing technology



Rosemary flower



Rosemary nursery



Essential oil

Rosemary (*Rosmarinus officinalis* L.) is a perennial aromatic plant cultivated all over the world for its essential oil and used in aromatherapy, medicine, cosmetics and have anti-inflammatory, anti diuretic and antimicrobial applications.

Market potential

Market is expected to grow to USD 1112 million by the end of 2025 at a CAGR of 10.5%.

CSIR-IHBT support to the farmers

- Improved agro and process technology
- Quality planting material.
- High yielding variety
- Trainings on agro and process technologies

Agro-technology for mass production of saffron (*Crocus sativus* L.)

Stigmas of *Crocus sativus* L. flower produces the most expensive spice in the world popularly known as saffron. It is widely used in food, flavor, pharmaceutical and dye industries.

Market potential:

- The global saffron market USD 881.7 million
- CAGR of 7.3% from 2020 to 2027.
- 90% of total saffron is grown in Iran

Salient features of CSIR-IHBT technology:

- Agro technology for production of saffron in non traditional areas
- Standardized tissue culture protocol for disease free production of corms

CSIR-IHBT support to farmers

- Introduction in non-traditional areas
- Skill development



Corms produced through tissue culture



Saffron

German chamomile (*Matricaria chamomilla* L.): agro and process technology



Dry flowers



Essential oil

Chamomile (*Matricaria chamomilla* L.) is an annual flowering herb commercially grown for its blue colour essential oil. Chamomile essential oil finds application in pharmaceutical industry specifically for anti inflammatory, antiseptic and antispasmodic formulations. It is suitable for cultivation in tropical to sub temperate areas.

Market potential

Demand of essential oil: 8000 MT per annum

CSIR-IHBT support to the farmers

- Improved agrotechnology
- High yielding variety rich in bisabolol & chamazulene.
- Quality planting material
- Skill development.

Improved bee hive for quality and hygienic extraction of honey

India is eighth largest producer of honey and exports approximately 61 million metric tonnes globally worth Rs. 800 crores annually. The honey market in India is estimated to reach Rs. 2800crores by 2024 at compounded annual growth rate of 10.2%. Government of India has identified apiculture and honey production as industry of national importance and dedicatedly launched 'Honey Mission'.

Conventional honey production involves series of extraction steps that uses heat and dehumidification assisted with centrifugal extraction process. This involves several manual and semi-automatic steps leading to uncertain quality standards. In addition, traditional methods are time consuming, labour intensive and cause high mortality of honey bees leading to poor honey quality fetching lower market price. This necessitates development of improved bee hive with inbuilt mechanisms for hygienic honey extraction.

In this context, CSIR-IHBT in collaboration with CSIR-Central Scientific Instruments Organization (CSIO), Chandigarh developed improved bee hive for hygienic extraction of honey with following salient features

- Extraction and harvesting of honey without disturbing the frames and honey bees.
- No mortality of honey bees during harvesting as compared to honey extractors.
- Yield of honey /hive/year is approximately 30-35 kilograms
- Portable, low cost device (only Rs. 5000/- per unit)



Internal view of improved bee hive with frames and key



External view of improved bee hive



Harvesting of honey in improved bee hive

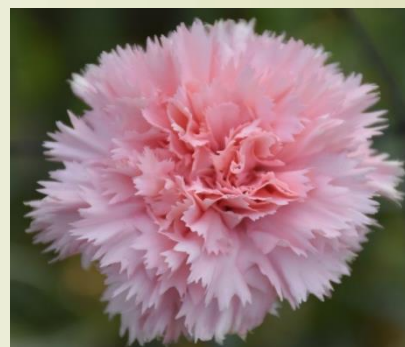
Agro-technology of Carnations



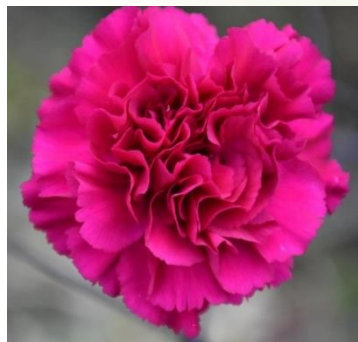
Domingo



Star



Alcazar



Farida



Yellow Dona



Baltico



Carnation field

Carnation (*Dianthus caryophyllus* L.) is a high value cut-flower crop that ranks among top ten cut-flowers in the world. Carnations are known for their fragrance, different colors and forms. These are suitable for protected cultivation in the mid hills region. The global trade market for Carnations for is estimated at USD 100 million presently. Considering the demand and high commercial value for Carnations, CSIR-IHBT has developed agro-technology protocols to produce cut flowers with following features

- Excellent keeping quality
- Light weight
- Ability to withstand long distance transport
- Further, CSIR-IHBT supports farmer community by
- Providing Carnation planting materials
- Training on cultivation practices

Alstroemeria: Agro-technology

Alstroemeria flowers have different colors with long flower stalks and are gaining popularity as novel cut flowers. Alstroemeria plants are suitable for protected cultivation under mid hills. The global trade of Alstroemeria in the international market is estimated at USD 20 million. CSIR-IHBT has developed agro-technology protocols for production of cut flowers with following

Salient features

- Different colored flowers
- Longer vase life
- Ability to withstand long distance transport.
- Further, CSIR-IHBT supports farmer community by
- Providing Carnation planting materials
- Training on cultivation practices



Serena



Pluto



Rosita



Butter Scotch



Himalayan Wonder



Himalayan Glory



Rose filed

Cut-roses: Agro-technology

Among all the commercially important flowers, rose occupies the supreme position for its exquisite beauty, shapes, exhilarating hues, excellent vase life and wide choice of varieties. These are suitable for protected cultivation under plains, low and mid hills. The global trade of cut roses in the international market is estimated at USD 794 million.

CSIR-IHBT has developed two cultivars through selection approach for commercial cultivation with following features
Bright colors - Red (*Himalayan Wonder*) and Pink (*Himalayan Glory*).

High yield – Greater than 26 cut-stems/ plant/ year.
Vase life of cut flowers are more than 7 days.

Further, CSIR-IHBT supports farmer community by

- Providing planting materials
- Training on cultivation practices

Chrysanthemum: Agro-technology

Chrysanthemums are extensively grown all over the world for their beautiful charming flowers with excellent vase life. These plants are cultivated as pot plants for beautifying indoors and outdoors, as cut flowers for making bouquets and as loose flower for making garlands and worshipping purpose. The global market for Chrysanthemum is approximately USD 365 million and is considered as elite flower in terms of trade volume.

CSIR-IHBT has developed five cultivars through hybridization and selection approach for commercial cultivation.

- **Him Aditya**-Yellow colored, Double flower shape with average flower diameter of 8.36 cm.
- **Him Ujjwala**- Brick red colored with yellow tip of florets, Double flower shape with average flower head diameter of 6.19 cm.
- **Him Pushkar**-Dark pink spoon shaped ray florets, Double flower shape with average flower head diameter of 7.99 cm.
- **Him Shringar**- Pink flowers, Double flower shape with average flower head diameter of 9.94 cm.
- **Him Shikhar**- Creamish white flowers with yellow centre, Double flower shape with flower head diameter of 6.91 cm.

Further, CSIR-IHBT supports farmer community by

- Providing planting materials
- Training on cultivation practices

Varieties registration under process



Chrysanthemum field



Him Pushkar



Him Ujjwala



Him Aditya



Him Shringar



Him Shikhar

Vertical gardening



Vertical gardens at CSIR-IHBT

Vertical Gardening is a special kind of urban gardening suitable to small spaces, particularly for decorating the walls and roofs in various styles. This is an alternative method for gardening by expanding the scope of growing plants in a vertical space. Intensive urbanization has left hardly any horizontal space for outdoor gardens. Green walls are helpful in enlivening the ambiance. Green walls can absorb heated gas in the air, lower both indoor and outdoor temperature, providing a healthier indoor air quality as well as a more beautiful space. The global market for vertical garden market is expected to reach USD 15 million and expected to grow at 6.18% CAGR during 2020-2025 period.

CSIR-IHBT provides

- Training and skill development on vertical gardening
- Consultancy for vertical garden projects

Indoor air pollution abatement plants

Air pollution is one of the most serious problems in the world. Indoor pollution in general 3 to 5 times higher than outdoor pollution. About 32% of Indians live in urban areas and about 90% of urbanites spend their time indoors. A poor air quality can cause eye, nose and throat irritation, headache, nausea, dizziness and fatigue leading to sick building syndrome. House plants are effective in reducing pollutants and improve indoor air quality. The domestic annual growth in the pot plant sector is 24% annually.

Salient features of these plants are

- Reduce up to 80% of volatile organic compounds indoor
- Reduce up to 84% of carbon mono-oxide indoor
- Reduce up to 55% of carbon di-oxide indoor

CSIR-IHBT provides:

- Training and skill development
- Technical know-how for indoor air pollution abating plants



Aloe vera



Areca Palm



Boston fern



Peace lily



Sansevieria



Spider plant

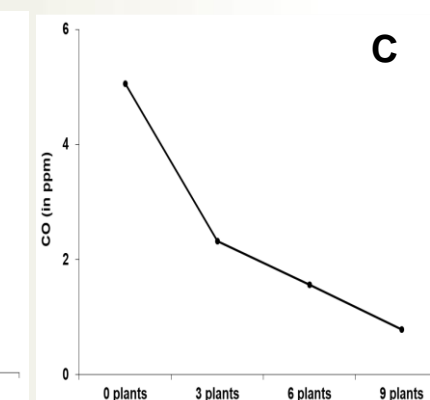
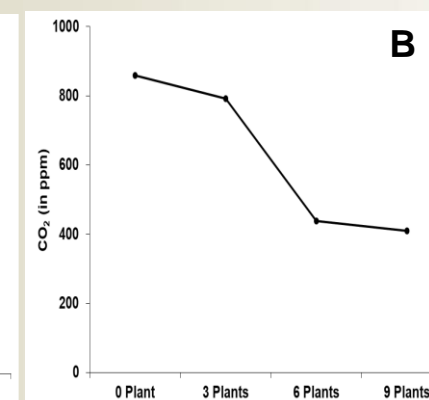
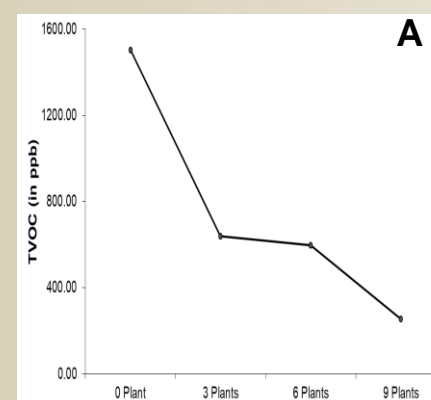


Fig. A. Reduction in TVOC concentrations indoors by Areca Palm

Fig. B. Reduction in CO₂ concentration indoors by Areca Palm

Fig. C. Reduction in CO concentration indoors by Areca Palm



FOOD TECHNOLOGY



Roasted barley grain based beverages

The coffee consumption in India has been largely concentrated in the Southern region, contributing to approximately 90% of the total domestic production of coffee beans. In the past two decades, consumption of coffee beverages has been spread to other parts of India, especially in urban centers. Coffee substitutes are non-coffee, specifically non-caffeine, products having similar sensory profile to coffee finding great applications in instant beverages and premixes category. Recent surveys indicate that global coffee substitutes market is USD 149 million with an annual growth rate of 9.5%. In this context, CSIR-IHBT has identified and developed a process for novel coffee substitutes in the form of roasted grains.

Our technology utilizes hull-less barley grains from high altitude regions such as Kaza, Lahaul&Spiti in Himachal Pradesh. Roasted barley grain beverage has similar aroma and sensory profile to coffee with the benefit of being caffeine free and source of dietary fibre.

Salient Features of Technology

- Caffeine free
- No bitterness
- Ready to reconstitute
- No chemical additives or preservatives
- Source of dietary fibre

Patent applied



Roasted barley

Low calorie herbal mouth fresheners (mukhwas)



Mukhwas or mouth fresheners is one of the largest categories within food, but largely unorganized. In several parts of India, after a round of desserts, there is a common tradition of ending a meal with *paan* (betel leaf) and *mouth freshener*. *Commonly consumed pan masala consists a mixture of areca nut, slaked lime, catechu, and condiments. Paan and mukhwas are primarily used as digestive aids and as an after meal snack.* Indian paan masala and mouth-fresheners market is worth INR 35,000 crores growing annually at 13%.

Despite traditional use and wide consumption across age groups, the mukhwas and pan masala market is unorganized and consists of artificial fragrances and colours, sweeteners and chemical preservative that adversely affect the human health. Considering the wide lacunae in the product category, CSIR-IHBT has developed herbal mouth fresheners (mukhwas) containing medicinal plants of Himalayan region. The product contains low calorie natural sweeteners such as steviosides addressing the needs of diabetic population. The product helps to keep the breath fresh and maintain oral hygiene.

Salient features of technology

- Herbal based formulation
- Anti-microbial composition for maintaining oral health
- Low calorie product suitable for diabetic individuals
- Free from artificial flavor and color
- Free from tobacco and adulterants

Patent applied

Value added food products based on honey

Honey is a sweet, viscous secretion by the bees after the assimilation of pollen and nectar. Honey gets its sweetness from the monosaccharides fructose and glucose and has relative sweetness similar to sucrose (table sugar). Honey has attractive physical and chemical properties and provide distinct aroma and flavor when used as sweetener in different food products. One hundred grams of honey provides 304 Kcal of energy making them a suitable alternative as natural sweetener. The honey and honey based product is Rs. 2.88 billion market in India with a projected annual growth of 10.2% for next 5 years. According to the National Bee Board, the average honey production in India is about 10 million metric tonnes and country exports honey worth USD 100 million. Honey based industries have been given importance under cottage industries, MSME and Farmers Produce Organization (FPO) schemes for empowering rural economy.

In this context, CSIR-IHBT has developed processes for preparing honey based food products for rural development such as

- Honey chocolate syrup
- Honey powder
- Honey Rosgulla&GulabJamun
- Honey Tea concentrate
- Honey fruits Preserve
- Honey Jelly (lemon & Chocolate)
- Honey fruit Barfi
- Honey Khamboocha

The salient features of the products are

- No added sugar
- High calorie foods
- Long shelf life more than four months
- Free from chemical preservatives
- Cost-effective
- Ideal for rural enterprises

Patent applied



Value added food products and technologies based on sohiong (*Prunus nepalensis*)



Sohiong fruit

Sohiong (*Prunus nepalensis*) is an underutilized fruit of North Eastern India. The fruit is a rich source of micro nutrients and antioxidants such as polyphenols and anthocyanin. Sohiong cultivation occupies an area of 300 ha, yielding 3000 tonnes of berries annually. The berries are under-utilized and needs global positioning. Considering the wide opportunity, CSIR-IHBT has developed various value added food products such as

- Instant energy Gel/Powder/Tablets/Drink
- Cordial, fruit syrup, Concentrate
- Preserve ,Chutney
- Ready to eat canned products
- Instant Energy shots

The technology utilizes cost-effective processes ideal for farmers produce organizations (FPOs), self-help groups (SHGs) and MSMEs

Salient features of the products

- No added preservatives and colors
- Do not require refrigeration
- Shelf life of the developed product greater than 6 months

Patent applied



Products developed using Sohiong

Value added food products and technologies based on seabuckthorn (*Hippophae rhamnoides*)

Seabuckthorn (*Hippophae rhamnoides*) popularly known as Leh berry or Cherma in Ladakh is a nutrient dense fruit rich in anti-oxidants such as vitamin C. The plant has cold-tolerant properties offering various health benefits. The total area under cultivation of Seabuckthorn is approximately 13,000 ha yielding 600 tons of berries annually. Despite several research reports on potential health benefits of Seabuckthorn berries, the plant is under-utilized and needs global positioning for wider market outreach. Considering the opportunity, CSIR-IHBT has developed various value added products such as

- Seabuckthorn beverage
- Bakery products
- Jellies(Seabuckthorn mixed fruit jelly)
- Instant energy/Gel/Powder/Tablets/Drinks
- Cordial , fruit syrup, concentrate

The products find application in food, beverage and nutraceutical industry. The technology utilizes cost-effective processes ideal for farmers produce organizations (FPOs), self-help groups (SHGs) and MSMEs

Salient features of the products

- No added preservatives and colors
- Products do not require refrigeration
- Shelf life of the developed product greater than 6 months

Patent applied



Seabuckthorn fruit



Value added products from sea buckthorn

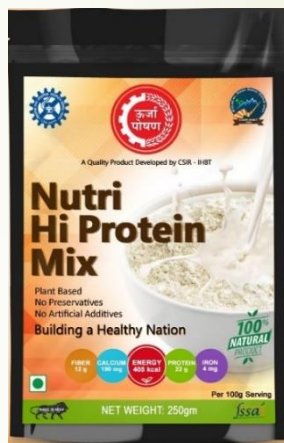
Protein and micronutrients enriched ready to cook foods



Ready to cook kichdi



Ready to cook dalia



Ready to reconstitute beverages(Porridge mix)



Protein and micronutrient malnutrition is a major health burden affecting almost 50% of children below 5 years and women of reproductive age in India. According to National Family and Health Survey 4 (NFHS 4, 2015-16), inability to meet recommended dietary allowances (RDA) of essential nutrients such as proteins, micronutrients such as iron, zinc are major cause for intra uterine growth retardation, iron deficient anemia, stunting and other morbidities.

In this context, CSIR-IHBT developed number of ready to cook, instant food products such as dalia, kichdi, and traditional beverage mixes, enriched with proteins, iron, zinc, calcium and vitamins.

Salient features of products are

- Nutrient dense ingredients such as millets, pseudo-cereals and pulses
- Both sweet and savoury variants
- Single serving of product meets 15% to 20% RDA of proteins, iron, zinc
- Iron and zinc enrichment through microalga – *Spirulina platensis*
- Vitamin D enrichment through Shiitake (*Lentinula edodes*) mushroom
- Ready to reconstitute in hot water or milk
- No chemical additives or preservatives
- Cooking time less than 7 minutes

Patent under process

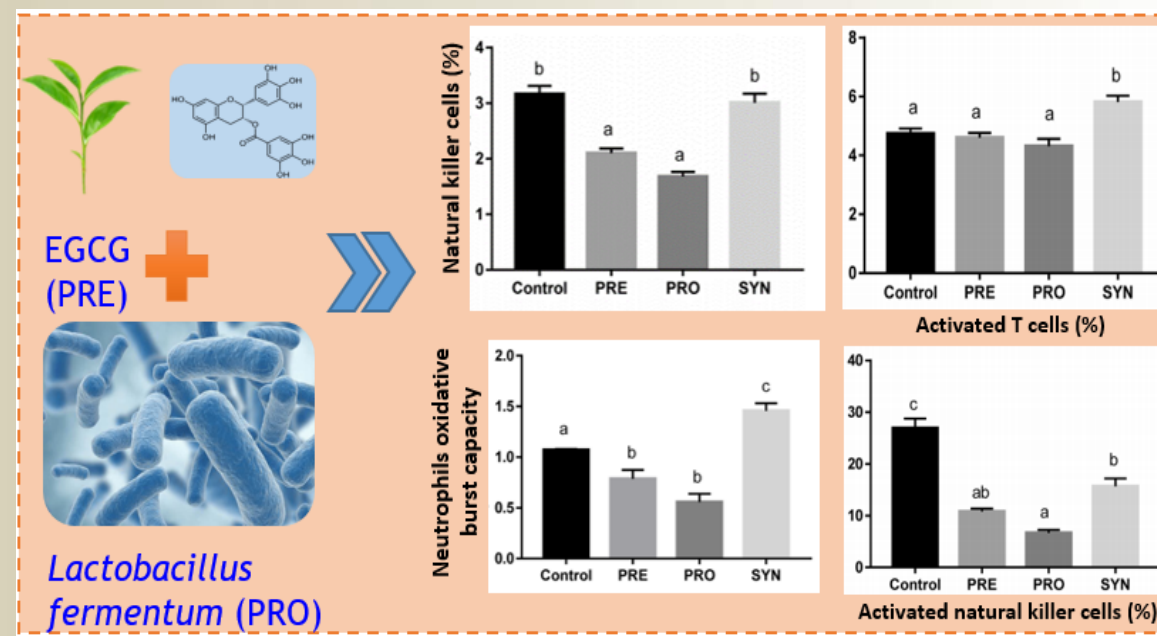
Tea based synbiotic nutraceutical

Synbiotic functional food is a combination of a probiotic bacteria and its growth promoting prebiotic agent. CSIR-IHBT developed a tea based synbiotic nutraceutical for augmenting systemic immune functions. The uniqueness of this formulation involves identification of a tea antioxidants as a prebiotic agent for a specific probiotic *Lactobacillus fermentum* that offer synergistic health beneficial effects. The formulation improves systemic immunity and antioxidant capacity which are desirable to promote health in general. The symbiotic nutraceuticals market is valued at USD 700 million and is projected to grow at 9% annually till 2028.

Salient features of the technology

- Enriched in both tea antioxidants and probiotic bacteria
- Shows synergistic health beneficial effects
- Improves immunity and antioxidant potential
- Effective in prevention of recurring infections and inflammatory disorders

Patent filed – PCT No. 201811026239



Tea based vinegar



Vinegar is a fermented beverage renowned for various health benefits. For diversification of tea and its value addition, CSIR-IHBT developed a tea based vinegar. This fermented beverage contains natural antioxidants and organic acids solely produced during fermentation. The experimental studies of this beverage have showed anti-obesity properties.

Market potential

Vinegar is major segment of fermented beverages with global market of USD 800 billion in 2018 and growing at CAGR (compound annual growth rate) of 5.7%.

Silent features of the technology

- Enriched in natural antioxidants and organic acids
- Each ml of tea vinegar contains 500-600 μg of gallic acid equivalent phenolics
- Each ml of tea vinegar contains 400-500 μg of trolox equivalent antioxidants
- Contains up to 50 g/L (5%) of acetic acid produced during fermentation
- Contains no added chemicals and preservatives

Patent applied

Herbal formulation for immunity modulation

In today's hectic lifestyle, consumers are increasingly concerned about their immunity and health. Consumers all over the world are very much concerned to boost their immune system in order to overcome infectious diseases. CSIR-IHBT developed an indigenous formulation which is suitable for intake with a range of food and nutraceutical products.

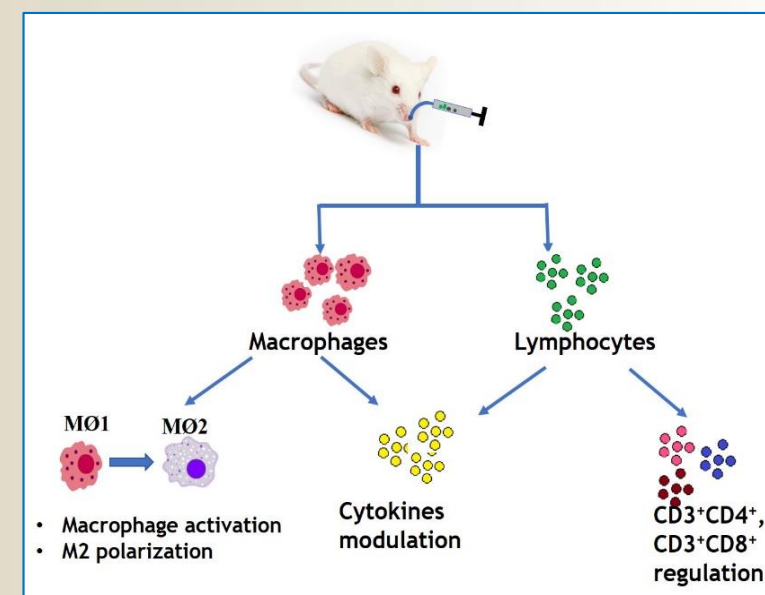
Salient features

- Green process
- Formulation contains major molecules
- Stimulates innate as well as adaptive immune response by regulating Th1 cytokine levels and modulates T cell subsets population in preclinical studies.

Patent applied



Herbal formulation



Modulation of immune response in mice

CHEMICAL TECHNOLOGY





Tea based hand sanitizer

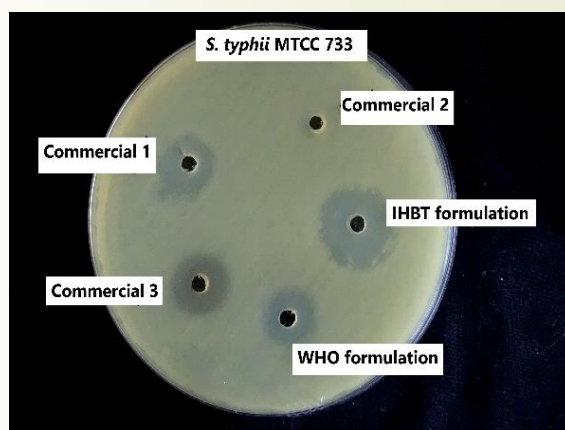
CSIR-Institute of Himalayan Bioresource Technology, Palampur (H.P.) has developed an alcohol-based hand sanitizer using tea constituents and essential oil that offers additional advantages. It is free from parabens, triclosan and synthetic fragrance. Laboratory tests confirmed the quality and sanitization activity of the developed formulation. Due to the presence of tea constituents and essential oil, this formulation imparts enhanced antibacterial properties as compared to the WHO formulation. This hand sanitizer is very effective in the wake of COVID 19.

Market potential

Recent global market for hand sanitizer is valued at USD 919 million and is expected to reach USD 3 billion by 2024.

Silent features of the technology

- Underutilized tea and tea parts are used as raw material
- Contains essential oil with antimicrobial activity
- Enriched tea constituents with antioxidant, antiviral and broad spectrum antimicrobial activity



Antimicrobial activity of hand sanitizer formulation

Patent applied

Tea based mouthwash

Oral hygiene is essential for maintaining fresh breath and healthy teeth and gums. Oral hygiene market is booming and is presently valued at USD 44.5 billion and is expected to reach USD 53.3 billion by 2025 with a CAGR of 3%. Several products that are available in the market contain synthetic chemicals, preservatives, artificial flavours and ethanol. With increasing demand for natural products, CSIR-IHBT developed 100% natural mouth wash enriched with tea constituents and blend of natural essential oils with broad-spectrum oral effectivity. The mouth wash contains natural sweetener and is free from sugars, sugar alcohols and other artificial sweeteners.

Salient features of the technology

- Enriched in natural antioxidants of tea
- Contains natural essential oils
- Possess antimicrobial activity
- Contains no added sugars
- Effective in prevention of bad breath

Patent applied



Antimicrobial activity of tea based mouth freshener

Process for 5-methylfurfuryl alcohol (MFA) production from biomass derived 5-HMF



Biomass: Rice straw, Sugarcane bagasse, Corn cob, Waste potato, etc.

5- Methylfurfuryl (MFA) is a feedstock for the production of biofuel 2,5-dimethylfuran (DMF). Some of the advantages of 5-MFA are its chemical stability, high energy density, low oxygen content, low volatility and good solubility in hydrocarbons. In addition to being a biofuel precursor, MFA finds applications as flavoring agent and additive in food industry.

Considering the increasing demand for MFA, CSIR-IHBT has developed a low cost, simple, atom economic and scalable process for production of 5-MFA from biomass derived 5-hydroxymethyl furfural (5-HMF).

Salient features of the technology

- Cost effective, atom economical, energy efficient, scalable process.
- Devoid tedious purification techniques
- Simple distillation gives high product purity >95%

Patents granted IN 202011007068



Scalable process for production of 4-alkyl resorcinols

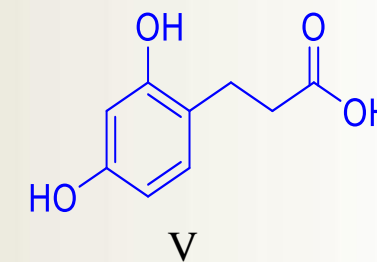
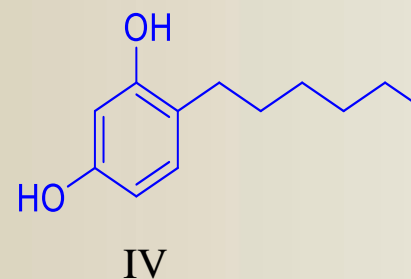
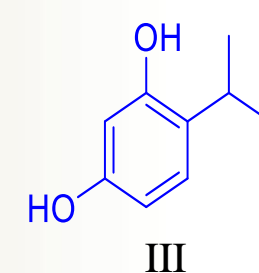
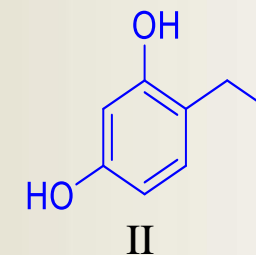
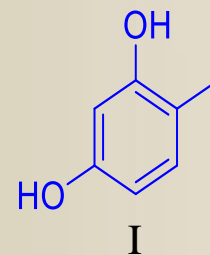
4- Alkyl resorcinols and its derivatives find extensive applications in cosmetics industry for production of lotions, creams, gels and masks that are primarily used for stabilizing colors, and in dyeing applications. The most commonly used 4-alkyl resorcinols in cosmetics are 4-Methyl, 4-ethyl-, 4-isopropyl, 4-hexyl resorcinols (chemical structures - **I-IV**), and 3-(2,4-dihydroxyphenyl)propanoic acid (chemical structure **V**).

CSIR-IHBT has developed a simple and economic process for the production of aforementioned compounds

Innovations in the process

- Commercially available and low cost starting materials
- Simple, scalable, and atom-economical process
- Process tested up to kilogram scale production

Patents granted WO2011/117881, PCT/IN2011/000180 and US 8,916,723 B2



Eco-friendly process for textile fibre from plant resources for various applications



Plant Material



Degumming



Cottonized fibre



Yarn

The increasing cost and decreasing availability of petroleum resources has increased the price of common fibers making them unaffordable for commodity textile applications. However, the global demand for textile fibres is increasing and estimated at USD 650 billion by 2025. Further, with the impetus given by Government of India to textiles industry there is an immediate need for identification of alternative fibres from renewable resources.

The process of extraction and separation of natural fibres from plant material is called retting. Retting involves series of biological, chemical and mechanical processes that are energy intensive, consumes high amounts of water, generate large quantities of process waste making the process uneconomical. In order to mitigate the above mentioned process issues, CSIR-IHBT has developed a cost-effective process for separation of natural fibres from underutilized, abundantly available and renewable lignocellulosic biomass

Salient features of the technology

- Low cost and eco-friendly process for fibres extraction having high quality and high counts.
- Downstream fibre separation process based on inexpensive, recyclable, industrial waste material.
- Less time consuming as compared to conventional methods
- Process has flexibility for processing plants having stalk diameter in the range of 8-13 mm
- Extracted fibres can be used for making pure yarns or blended yarns

Patent applied- 0054NF2020

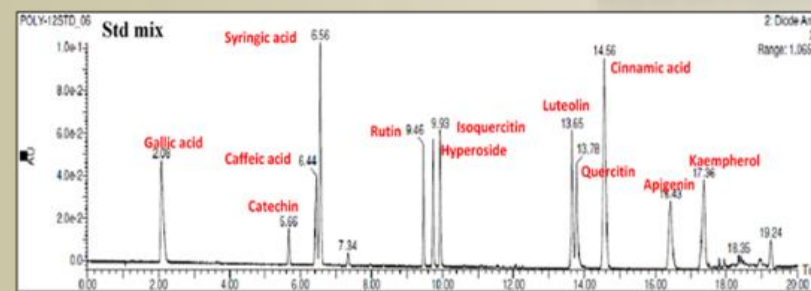
Herbal based liquid hand wash

The global trend of increased personal hygiene and the impetus given by the Indian Government for good hygiene practice in the wake of recent covid-19 pandemic is driving the market for development of innovative hygiene products. The Indian Hand hygiene market is expected to reach INR 2160 crores by the year 2025. To meet the demand for natural and effective hand hygiene products, CSIR-IHBT has developed an herbal liquid hand wash with antimicrobial properties.

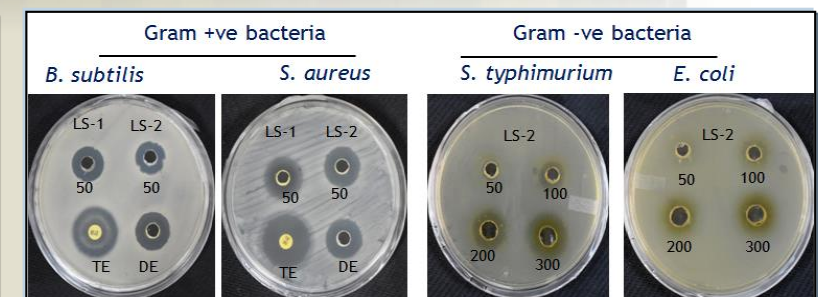
Salient features of the product

- Natural extracts rich in saponins, amino acids and polyphenols
- Vitamin E (tocopherols) rich oil
- Natural moisturizers
- Contains camphor, lemon grass oil and economical soap base sodium lauryl ether sulphate (SLES) / Spindus extarcts
- Broad spectrum antimicrobial activity
- Irritation free

Patent applied



Chemical profile



Antimicrobial activity

Chemical free herbal soap



Soaps are salts of fatty acids, produced by process of saponification. Triglycerides derived from vegetable or animal fats are primarily used for production of soaps. Soaps have surfactant property and solubilizes particles and grime. Soaps are integral part of personal hygiene and global toilet soap market is expected to reach USD 26 Billion by 2024.

Majority of the soaps available in markets are made of detergents such as sodium dodecyl sulphate (SDS), sodium lauryl ether sulphate (SLES) and mineral oil that pose risk of allergies and other dermatological problems. Despite the presence of several brands of soaps, the demand for herbal soaps are increasing owing to non-toxic nature and enhanced anti-microbial activity. Considering the market demand, CSIR-IHBT developed a natural herbal soap with following

Salient features of the technology

- SDS and SLS free
- Animal fat free
- Mineral oil free
- Natural ingredients
- Plant extracts having saponins, amino acids, polyphenols, vitamins
- Natural approved fragrances
- Natural oils as moisturizer
- Excellent cleansing and moisturizing activity
- Antibacterial activity
- Antidandruff activity
- Irritation free

Patent applied

Herbal lipsticks

Cosmetics like lipsticks are applied on the thinnest part of skin to color, beautify and protect from harsh environmental conditions. Conventional lipsticks are made of artificial colours stabilized by additives and preservatives. The absorption of potentially toxic elements is very high in the lips and may significantly increase the carcinogenic risk to humans. The concern about safety and health of consumers has opened up plethora of opportunity for natural pigments and colours in cosmetics industry.

In this context, CSIR-IHBT developed an eco-friendly, green process for formulation of lipstick consisting of natural pigments from plants/vegetables sources. Although lipstick is a small segment of the cosmetics industry, it attracts a market worth USD 8 billion globally.

Some of the salient features of the technology are

- Green process of colour extraction
- Natural colours with high temperature and light stability
- Non toxic
- Free from heavy metals and preservatives

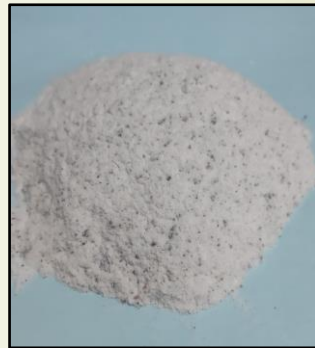
Patent applied



Formulation promoting cartilage health



Topical Formulation



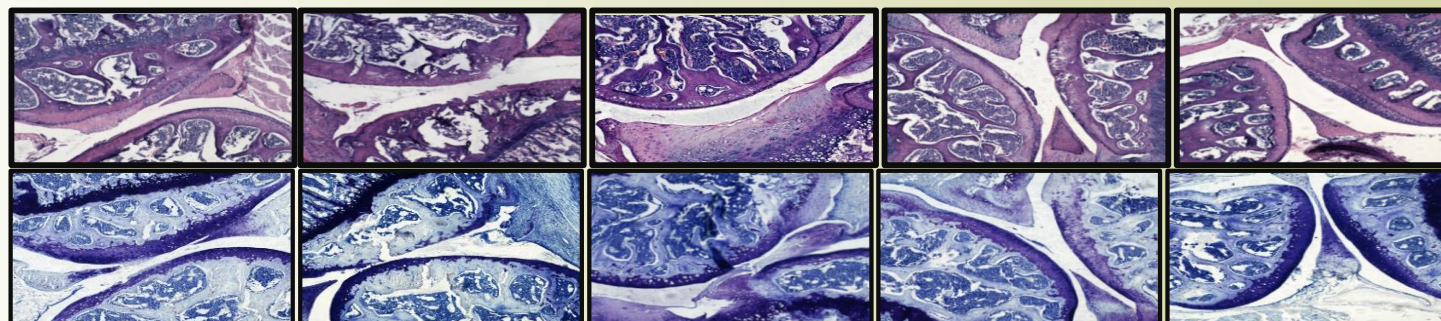
Oral Formulation

- An estimated 25 million Indians affected from osteoporosis and poor cartilage health
- Available drugs possess several side effects leading to inclination towards herbal products
- There is increased interest towards developing safe and affordable alternative therapies based on traditional knowledge

Salient features:

- Developed formulation maintains cartilage health and inhibits cartilage degradation
- Sugar free ready to use formulations (Topical cream, Free flowing powder & Syrup)
- All ingredients used, permitted under FSSAI/FDA regulations
- Preclinical evaluation and stability studies completed

Patent applied



Control

Diseased

Syrup

Extract

Powder

Formulation showed beneficial effects on cartilage in preclinical studies

Herbal oil for dandruff prevention

In today's advanced lifestyle, consumers are conscious about their beauty and health. Consumers all over the world are very much concerned to prevent dandruff. CSIR-IHBT developed a herbal hair oil with antidandruff, antibacterial & conditioner properties.

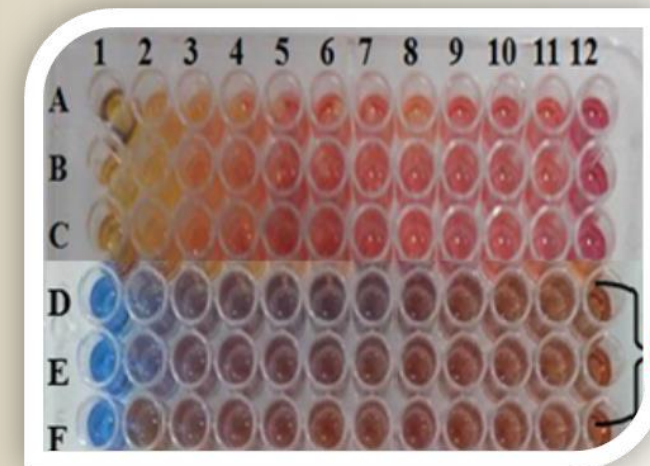
Salient features:

- Green process
- Effective antifungal, antibacterial & conditioner.
- Free from animal fats and mineral oil
- Antidandruff activity (MIC is >10 mg of oil on *M. furfur* fungus).
- No irritation.

Patent applied



Herbal hair oil



Herbal oil-1

Ketoconazole

Antidandruff activity

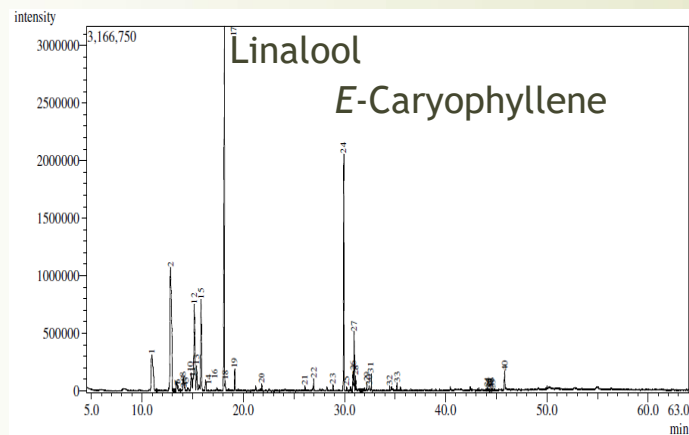


Natural perfumes

Appearance and personal care have become sense of pride, self reliance and confidence. Consumers are plowing more of their income into goods that they think will help them stay healthy and happy.

Fragrances enhances mood, boost confidence, makes one attractive.

It boosts health, trigger memories, treat insomnia, cures headache and used in aromatherapy.



Chemical constituents

Market Potential

The global perfume market size is expected to reach USD 40.9 billion by 2025 with a CAGR of 3.9 %

Salient features

- Soothing, warm and woody aroma
- No added synthetic aroma chemicals
- Contains blended natural essential oils
- Mask bad odours and keeps fragrant throughout the day

Lip balm

Lip balm is formulated with all natural ingredients, helps with chapped and dry lips. Natural butter is a rich moisturizer with soothing and healing properties. Due to its rich texture, the skin doesn't soak it up right away, allowing the butter to serve as an extra protective barrier on the surface of your skin and lips to allow them to hydrate and heal. Additionally, essential oil used has antioxidant, antibacterial and anti-inflammatory properties.

Market potential

The global lip care products market size was valued at USD 712.8 million in 2018 and is projected to exhibit a CAGR of 7.2% annually.

Silent features of the technology

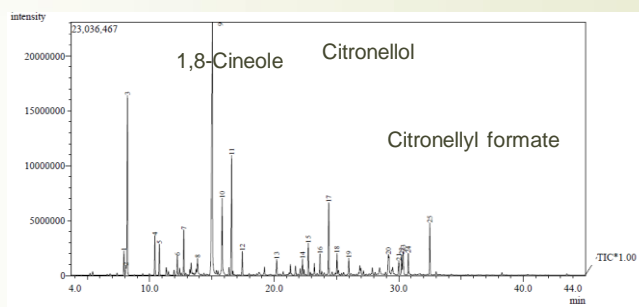
- Made with natural colors
- Made with essential oils and natural butter
- Free from synthetic fragrances
- No added chemicals and preservatives

Patent applied





Room freshener



Chemical constituents

Air fresheners

Air freshener is a product to mask unpleasant odors in a room. It contains different ingredients such as aerosol, propellants, fragrances, and solvents. Air fresheners are being used throughout society such as offices, schools, hospitals, theaters, stores, hotels, health clubs etc. Apart from these indoor environments, they are also being used in transportation such as airplanes, cars, taxis, buses, trains, terminals, boats, and many more.

The dynamic growth in the demand of the easy life style and modernity are two major factors contributing towards the growth of the market.

Market Value:

The global air freshener market is expected to garner \$13,279.1 million by 2025 with a CAGR of 3.5% from 2018 to 2025

Salient features:

- Stimulating and refreshing aromas
- Contains blend of natural essential oils
- No added synthetic chemicals
- Water and alcohol based formulations
- Makes the room and car environment fresh and pleasant

Mosquito repellents

Plant-based repellents have been used for generations in traditional practice as a personal protection measure against mosquitoes. Recently, plant-based commercial repellent products have gained increasing popularity among consumers, as these are commonly perceived as “safe” in comparison to long-established synthetic repellents of the various types of mosquito repellents in market, vaporizer repellent have the largest market value

Market Value:

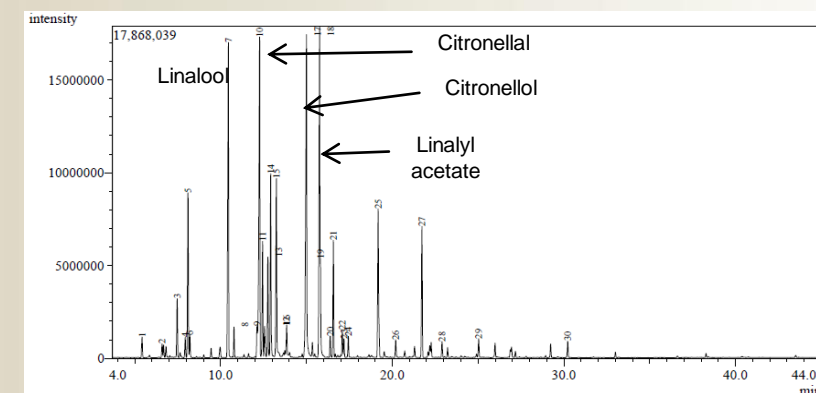
- The global mosquito repellent market size was valued at \$ 1.4 billion in 2020
- It is estimated to reach \$ 6.0 billion by 2027 with CAGR of 5.6% from 2020 to 2027

Salient features:

- Citrus and refreshing aromas
- Contains blend of natural essential oils
- Alcohol based formulations
- Mosquito repellent activity
- Free from synthetic chemicals



Mosquito repellents



GCMS chromatogram

Clary sage (*Salvia sclarea*): agrotechnology

Clary sage (*Salvia sclarea* L.) is one of the most important medicinal and aromatic plants cultivated worldwide for essential oil and other perfumery products. Leaves, floral spikes and essential oils are used as flavoring in food and beverages, fragrances, aromatherapy and traditional medicine. Clary sage is also used to treat asthma, stress, depression, fatigue, migraine, nervousness, hemorrhoids, oily skin, spasmodic cough, digestive and menstrual problems. Linalool, linalool acetate, geranyl acetate and sclareol are the major constituent of clary sage oil.

Market potential

The global market for clary sage oil is currently estimated at USD 708 million at a CAGR of 4.2% and is expected to reach USD 1,184 million by the year 2033.

Salient features of CSIR-Technology

- Sclareol rich (40%) selection
- Yield potential of 17.26 tonnes/ha (flower spikes)
- Essential oil content (0.232%)

Contribution of CSIR-IHBT

- Standardized agronomic practices
- Technology for essential oil extraction
- Training on agro and processing technology



Mass propagation of *Phyllostachys pubescens* Mazel ex Houzeau de Lehaie: Chinese moso bamboo



Moso bamboo is highly valued for its economic and ecological benefits, with applications ranging from food and construction materials to crafts. Traditional propagation methods are limited by irregular flowering, low seed viability, and unpredictable seed production. Tissue culture techniques, including somatic embryogenesis and organogenesis, provide a viable alternative for rapid and large-scale propagation. This approach ensures a sustainable supply of high-quality plantlets, promoting the widespread cultivation and utilization of moso bamboo in various industries.

Market Value:

Global bamboos market size was estimated at USD 64.45 billion in 2022, expected to rise USD 94.38 billion by 2030.

Salient features:

- Optimization of time effective protocol for rapid multiplication of *Phyllostachys pubescens*.
- Easily scalable protocol, year round production, uniform quality produce
- This will facilitate its genetic improvement and conservation.
- Skill development on micropropagation





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