

Reaching the unreachable

The innovation path of converging sciences into business

Suman PS Khanuja
Director

SKiES Life Technologies Pvt. Ltd.

Bringing nature to life

???

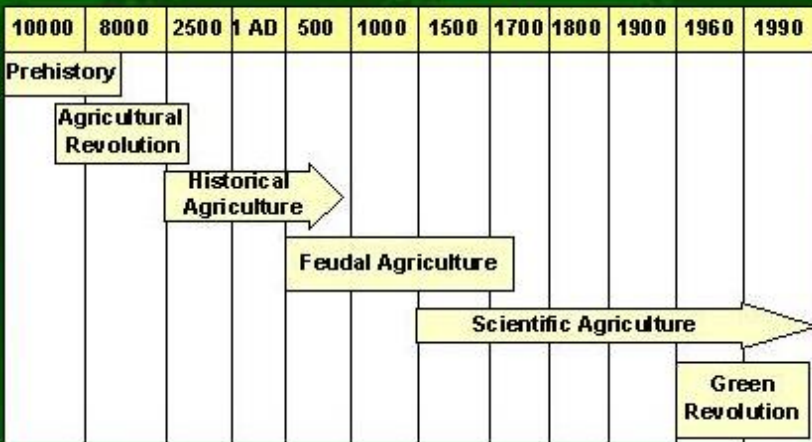
Not to follow

Innovate

Tall grows to dwarf

Innovate

Evolution of Agriculture



Dwarf gene
Dee geo woo ger

Green Revolution



Hybridization

Emmer

• Purely accidental

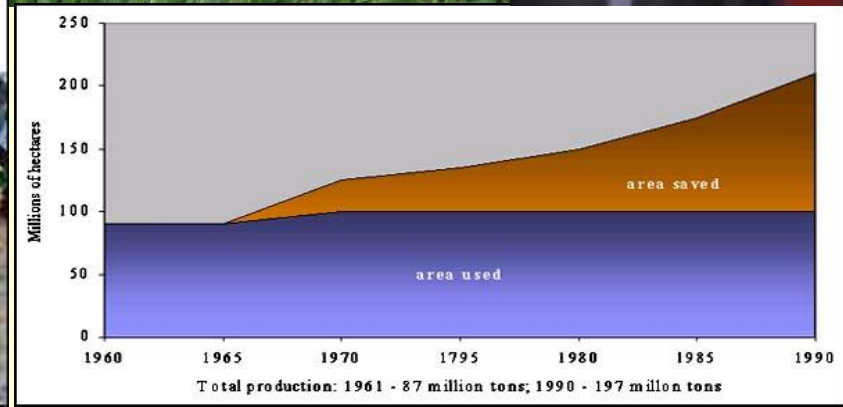
- ♦ Wild wheat X goatgrass
 - 14 + 14 chromosomes
- ♦ Produced fertile hybrid "**emmer**"
 - Diploid (28 Chromosomes)
 - Dispersed by wind
- ♦ Emmer X goatgrass
 - 28 + 14 chromosomes
 - Fertile hybrid "**bread wheat**"



4n



6n



Yes !

Think beyond

Innovate

Example !



“Plants do not speak, they just whisper! Therefore, you have to be real close to them to understand them!!” – *derived from Norman E Borlaug*

Plants

Molecules of Drug Value....

Did you think

Why ?

We did & We do !!

and we know...

Terpenes

Alkaloids

Plant's have an armory

Flavanoids

Glycosides

Saponins

India is going the way of developed countries. With the per capita income of Indians on the way up, lifestyle diseases are projected to replace infectious diseases as the major chunk of illnesses in the country.

The healthcare study was carried out by the Confederation of Indian Industry in association with McKinsey and Co.

The treatment of obesity has proven that it can reduce the onset of **lifestyle diseases** such as hypertension, high cholesterol levels, diabetes mellitus, and even erectile dysfunction.

Nervine
Obesity
Diabetes
General tonic

Drug Therapeutics billion \$ Categories

- Inflammatory/Immunological
- Cardiovascular
- Metabolic/endocrine
- Anti-infectives
- Oncology
- Neurological
- Pain

Plant sourcing...

Nervine tonics

Asparagus racemosus, Saponins



Acorus calamus, Phenyl propanoids

***Withania somnifera*, alkaloids**



Bacopa monnieri, Triterpenoid saponins

Centella asiatica, Triterpenoid saponins



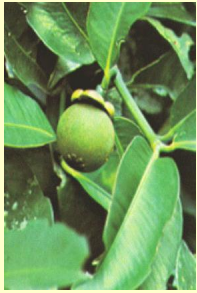
Nelumbo nucifera, Alkaloids

Plant sourcing...

Anti-Obesity

Obesity leads to

- High blood pressure
- Diabetes
- Abnormal blood fats
- Coronary artery disease
- Stroke
- Osteoarthritis
- Sleep apnea
- Cancer



Ephedra sinica, alkaloids ephedrine and pseudoephedrine



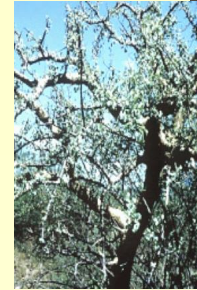
Garcinia cambogia, hydroxycitric acid (HCA)

Hypericum perforatum, Hypericin, polycyclic quinone



Red apple, Pyruvate.

Commiphora mukul, steroid, guggulesterone



Saccharum officinarum Policosanol

Camellia chinensis, Flavanoid, Caffeine



Allium sativum, Alicin (Diallyl thiosulfinate)

Beta sitosterol

Annona cherimola, *Nigella sativa*, *Oenothera biennis*,
Salvia officinalis, *Morus alba*, *Fagopyrum esculentum*,
Ocimum basilicum, *Zea mays*, *Glycyrrhiza glabra*,

Ascorbic acid: *Hippophae rhamnoides*, *Capsicum annuum*, *Anacardium occidentale*, *Momordica charantia*, *Moringa oleifera*, *Capsicum frutescens*, *Manihot esculenta*, *Raphanus sativus*, *Emblica officinalis*

Citric acid: *Hibiscus sabdariffa*, *Ananas comosus*, *Citrus limon*, *Citrus paradisi*, *Garcinia mangostana*, *Glycine max*, *Punica granatum*, *Citrus sinensis*, *Zizyphus jujuba*, *Fragaria spp*

Beta Carotene: *Morinda citrifolia*, *Luffa aegyptiaca*, *Mimosa pudica*, *Spinacia oleracea*, *Daucus carota*, *Capsicum annuum*, *Ipomoea batatas*, *Brassica nigra*, *Beta vulgaris*

Amla - The Richest Natural Source of Vitamin C. 8.7 mg of Vitamin C from Amla = 100 mg of Vitamin C from synthetic sources

Plant sourcing...

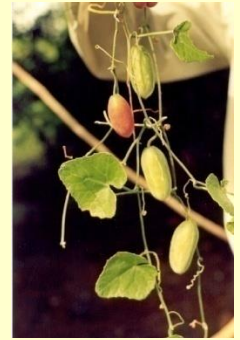
Anti-Diabetes



BitterGourd (*Momordica Charantia* L.). Seed extract
(Protein) p-insulin



Coccinia indica ,
Triterpenoids, Taraxerone



Gymnema sylvestre,
Gymnema saponin



Pterocarpus marsupium, flavonoid



Lagerstroemia speciosa, Triterpenoids, corosolic acid

Trigonella foenum-graecum alkaloids, Trigonelline
and Choline



Stevia rebaudiana bertonii Stevioside, diterpene glycoside



Tinospora cordifolia
Tinosporin, cordifolide, diterpene



Plant sourcing...

Anti-Cancer

Colchicum autumnale, colchicine(alkaloid)



Betula alba, Betulinic acid (Triterpene)



Camptotheca acuminata, camptothecin (alkaloid)



Cannabis sativa, tetrahydrocannabinol (Sesquiterpene)



Podophyllum hexandrum, podophyllotoxin (lignan)



Nothapodytes foetida, camptothecin (alkaloid)



Catharanthus roseus, Vincristine, vinblastine (alkaloid)



Taxus wallichiana, Taxol(diterpenoid)

And we need...

ABC



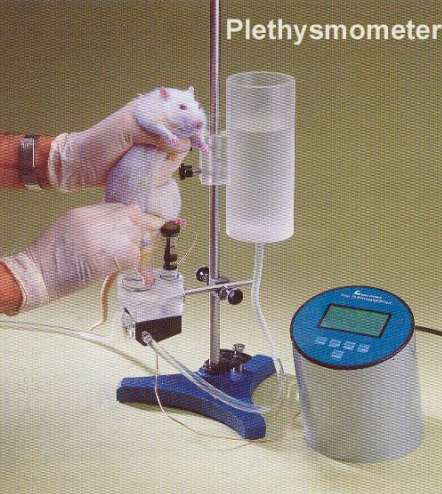
Agriculture



A



Agrotechnology



Biology

Microarray
MALDI-TOF-TOF
Real time PCR
Automated DNA Sequencer
DNA Synthesizer

B

DNA Fingerprinting
Transgenic Facility
Functional Genomics
Animal Cell culture
Bioprospection



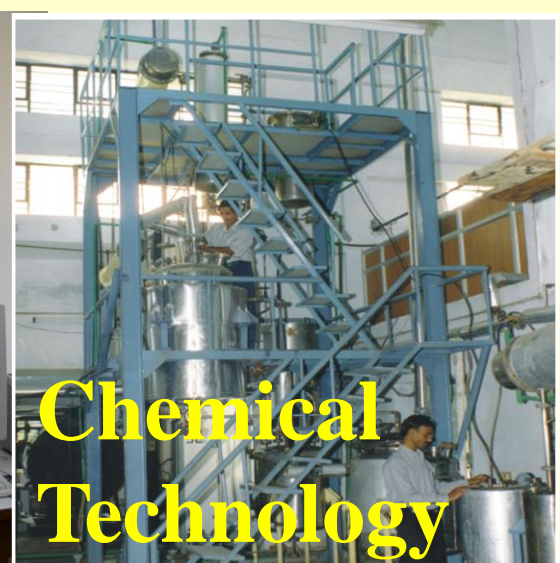
Biotechnology



Chemistry



GLC
GC-MS
NMR
LC-MS
HPLC
HPTLC
Pilot Plants
Distillation Units



Chemical Technology



The Strategy

Reach the unreachable
...and link the unlinked



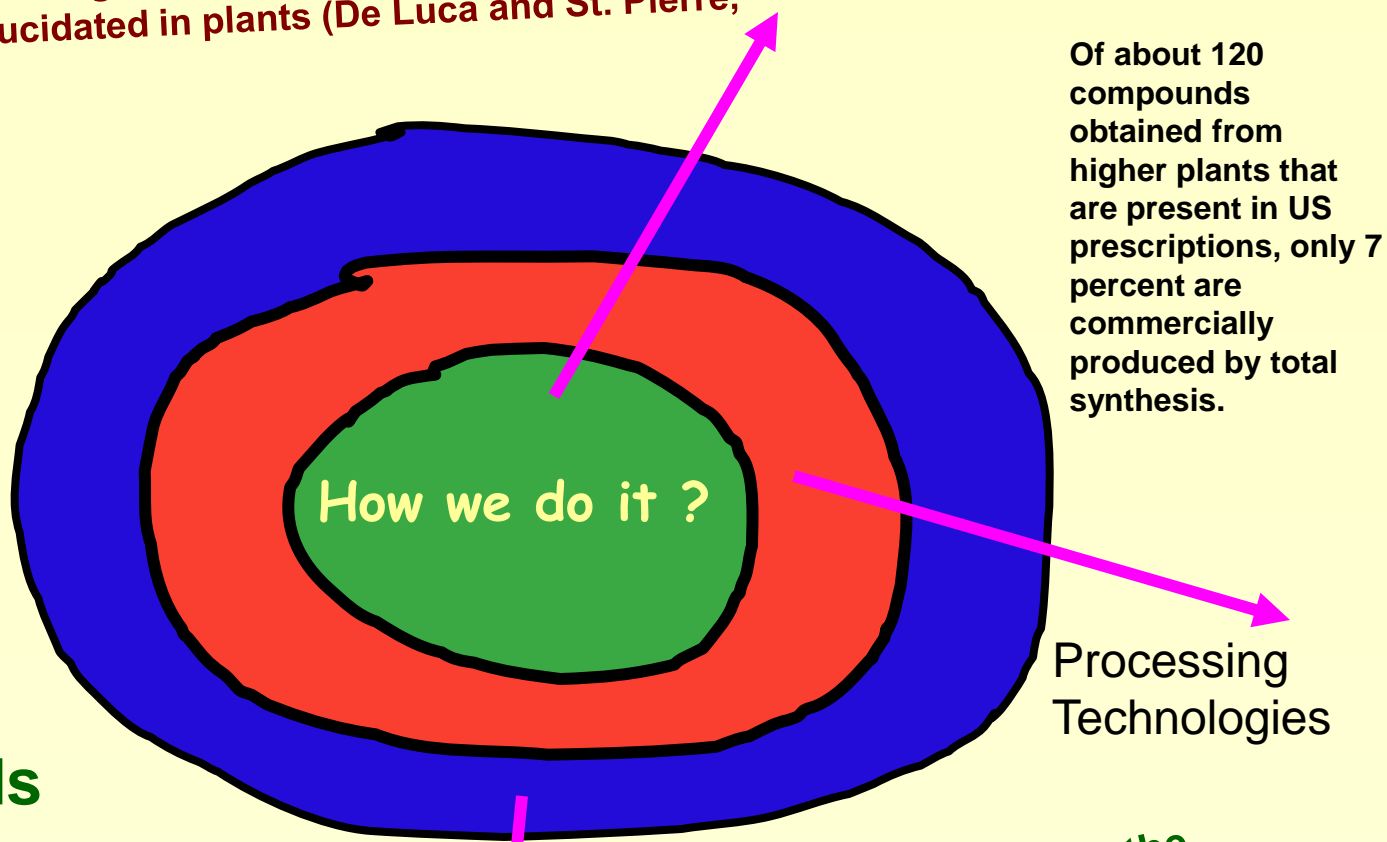
With upto 50,000 genes estimated in plants, more than 200,000 phytochemicals have been anticipated (Pichersky and Gang, 2000) with already around 50,000 compounds elucidated in plants (De Luca and St. Pierre, 2000)



Alkaloids

Phenolics

Terpenoids



Plant (About 3.5 million)

Of about 120 compounds obtained from higher plants that are present in US prescriptions, only 7 percent are commercially produced by total synthesis.

Processing Technologies

Products??

Going by the numbers, the metabolites identified so far comfortably cross 200,000 figure while the number of such phytomolecules expected is at least a million if not several millions.

Opportunities

Can we produce metabolites at will in non-conventional plants?
Sustainable harvesting? make perennial plants?
What is the wealth of nature?

Plant improvement (Biomass)

Designer plants

Active compound yield

Plant Biotechnology

Marker assisted breeding

Metabolites *in vitro*

Quantification of diversity

Genomics

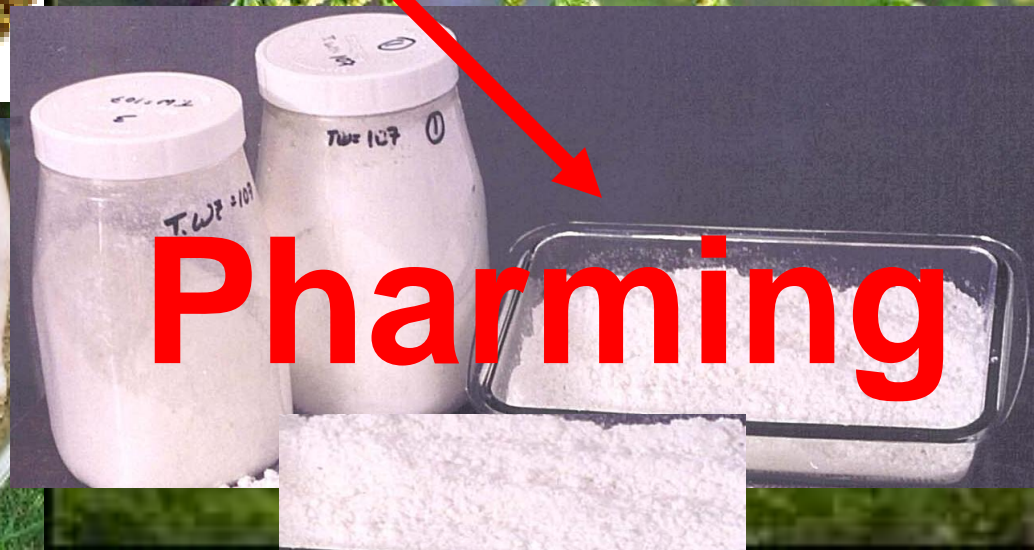
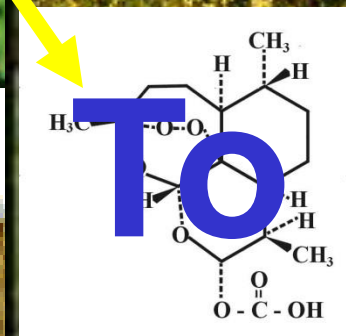
Proteomics

Farming to Pharming





Farming



Pharming



Distillation by farmers



The footprint of R&D



Marketing of essential oil



From kachha to pucca house

Futuristic vision for mint research

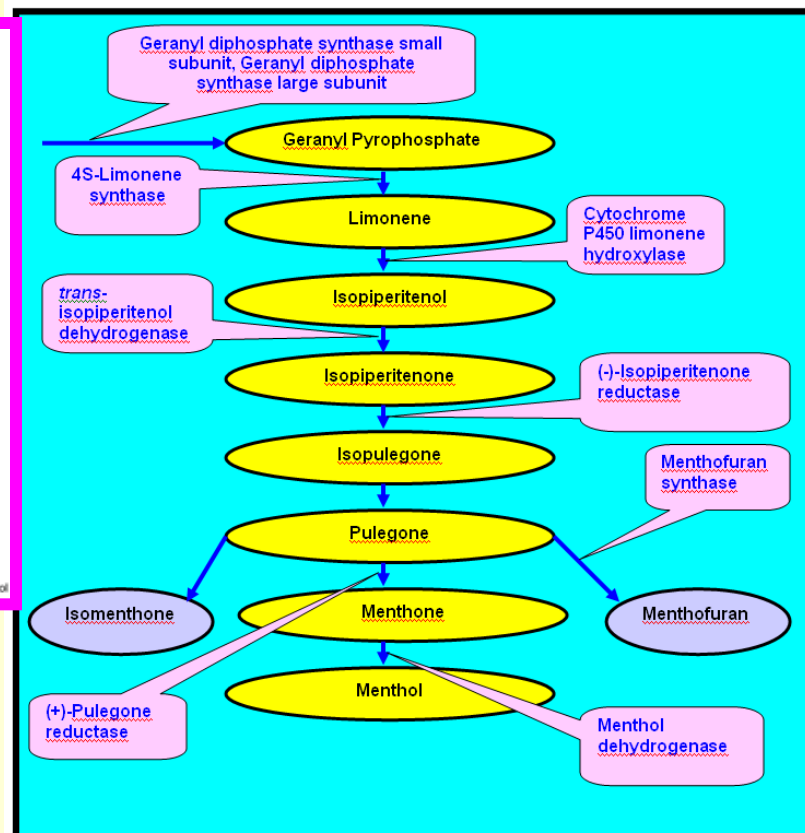
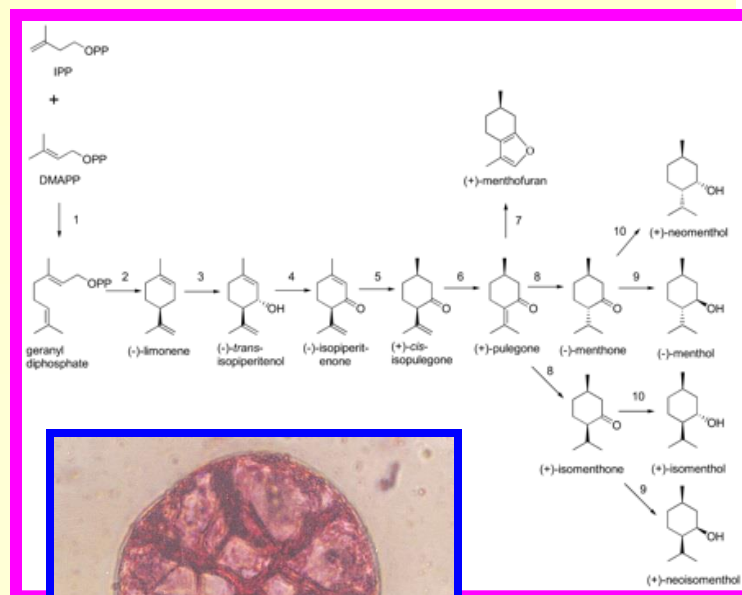
India exported 9546 tonnes of menthol 2005-2006 worth Rs 550.29 crores (Department of Commerce, Govt. of India).

India is the largest consumer of menthol with a figure of about 3100 metric tons in 2003

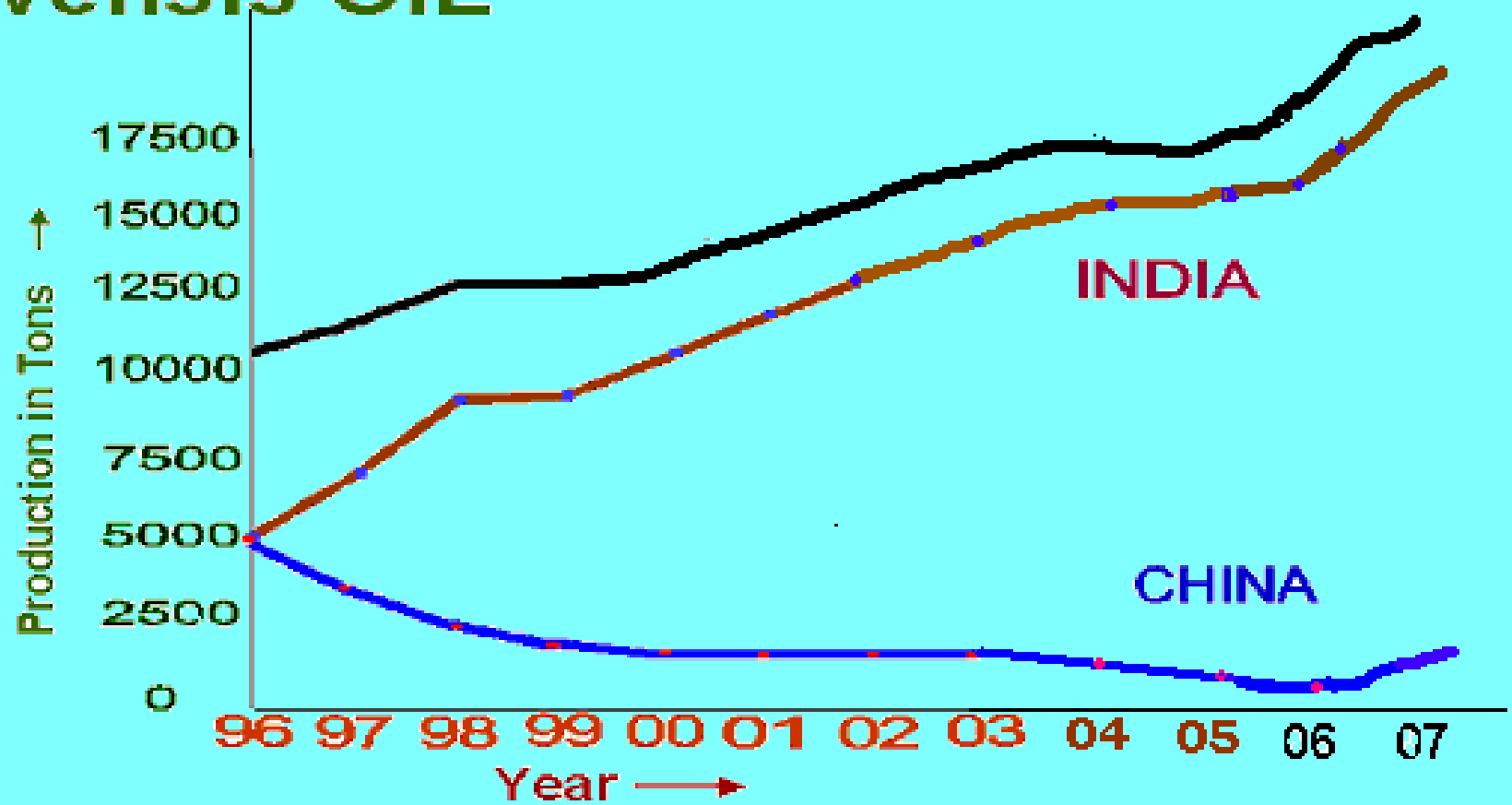
- The natural oil yields on an average 40-50% menthol and 50-60% dementholised oil, which can be used both in confectionery and medicine in place of imported peppermint oil.
- Japanese mint oil is not distinguished from the peppermint oil in the Indian trade.
- The dementholised oil has been found to contain menthyl acetate (24.4%), free menthol (44.8%), menthone (24.6%) and hydrocarbons (6.2%). Among the hydrocarbons, alpha-pinene, a-1-limonene, carophyllene and cademene are present

10000 tonne of dementholated oil

25% Menthone = 2500 tonne menthol + 4480 **free** menthol



M.arvensis OIL



Source: Shri SC Varshney, Mint Meet 2007, Lucknow

Impact of futures trading on Mentha market

Particular			
<i>Acreage</i>			
<i>Production</i>			
<i>Price</i>			
<i>Sales Value</i>			
<i>Export</i>			
<i>India's Share in world production</i>			
<i>India's Share in world trade</i>			
<i>Average Export realization</i>			
<i>Total export</i>			

Export of Major Spices from India

(QTY IN M.T; VALUE RS CRORE)

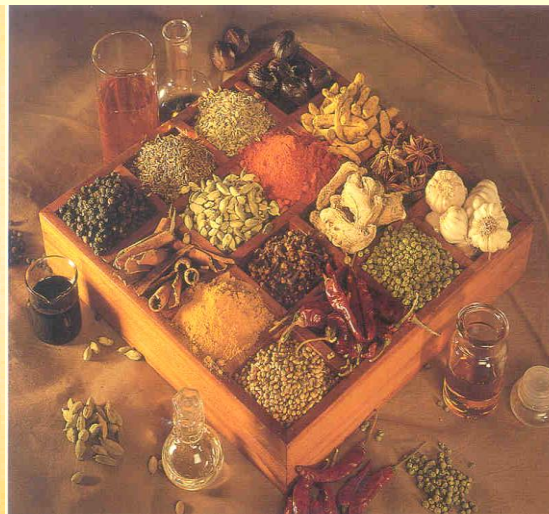
ITEM	2006 – 07(E)	
	QTY	VALUE
PEPPER	28,750	306.02
CARDAMOM(S)	650	22.36
CARDAMOM(L)	1,500	16.95
CHILLI	148,500	807.75
GINGER	7,500	39.75
TURMERIC	51,500	164.80
SEED SPICES	70,125	362.52
VANILLA	125	19.96
CURRY POWDER	9,500	86.93
MINT PRODUCTS	16,250	1100.95
OILS & OLEORESINS	6,250	510.79
TOTAL (Including Others)	373,750	3575.75



India's Share In Value Added Spices

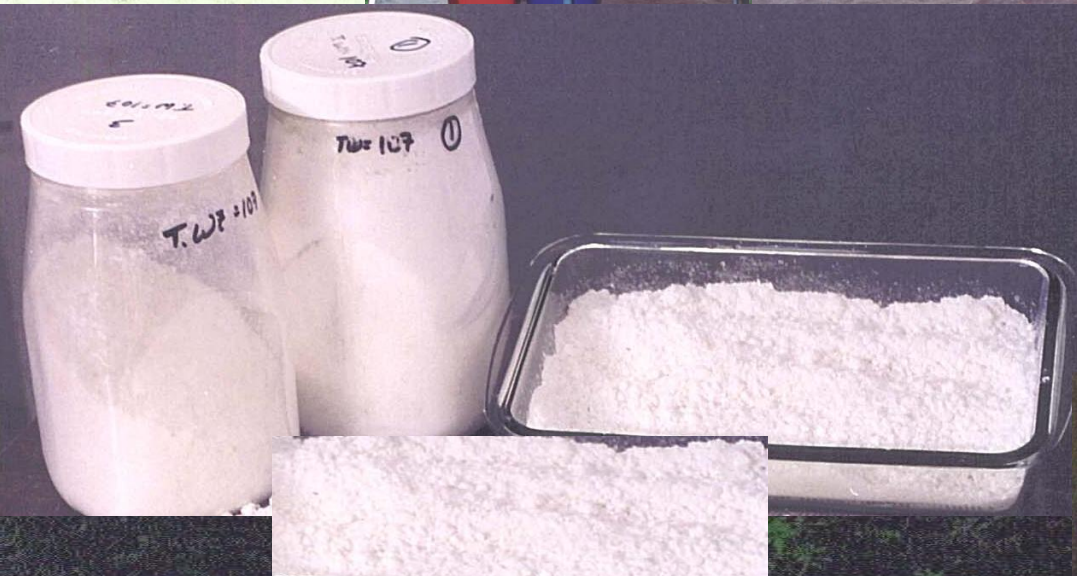
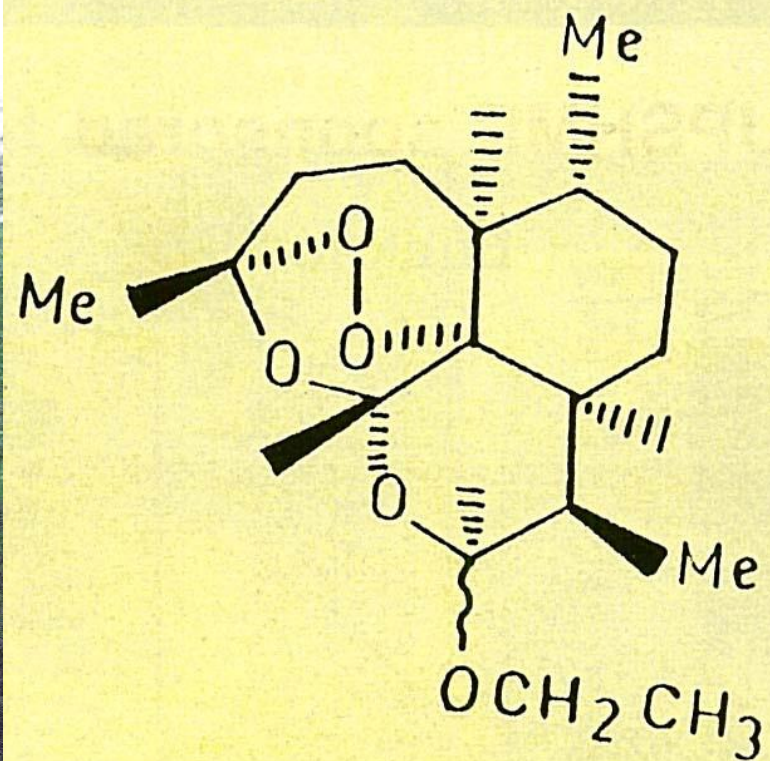
Qty in Tons

SPICES	INDIA'S EXPORT	WORLD TRADE	% SHARE
SPICE OILS & OLEORESINS	6250	7500	83
MINT PRODUCTS	16250	30000	54

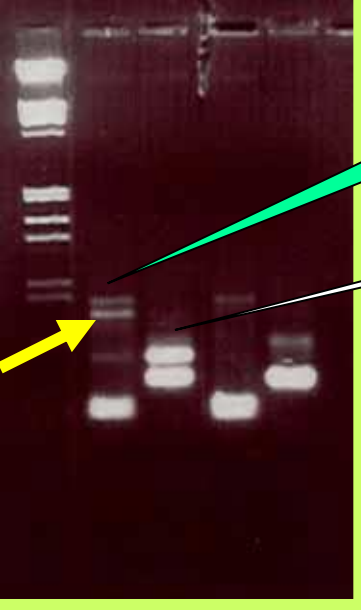


Plant molecules for Health

- Natural Products as drugs
- Industrial partnership
- Agro base
- Societal impact



Artemisinin and arteether



High type

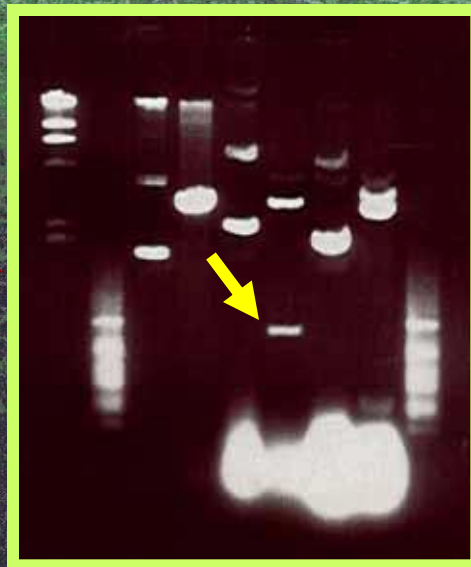
Low type

Synthesis of primers

Sequence

Clone

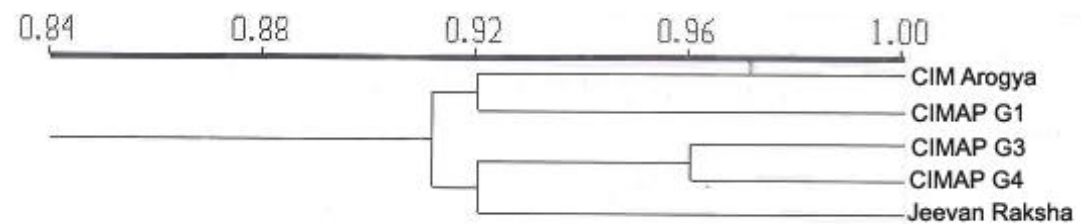
PCR



Biotechnology Research

CIM-Arogya

For drug intermediate Industry



High artemisinin containing variety 'CIM-Arogya' of *Artemisia annua* and its production technology package licensed to M/s Themis Medicare on 18 May, 2004 on the occasion of 31st RC Meeting



Signing of agreement with Sanat Products , New Delhi on 11.1.06 for technology licensing of *Artemisia annua* cultivation and processing



Licensing Agreement for CIM-Arogya signed with Vital Healthcare, Mumbai on 19.1.2005



Signing of agreement with Bharthi Society (TN) on 3rd August, 2005 for cultivation of antimalarial drug plant *Artemisia annua* var. Jeevanraksha involving women farmers



M/s Biotech International Limited, New Delhi signed agreement with CIMAP on 5th September, 2005 for acquiring technology for cultivation and processing of *Artemisia annua*



Signing of technology licensing agreement with M/s Scimitar Biotech Pvt. Ltd, New Delhi on 17th November, 2005 for CIM-Arogya technology demonstration in Chandigarh



Signing of agreement with GSFC, Vadodara on CIMAP Annual Day on 26th March, 2006 for licensing industrial technologies of *Artemisia*, *Silybum* and *Geranium*

Artemisia Biovillage









Campaign to fight malaria hit by surge in demand for medicine

David Cyranoski, Tokyo

An alarming shortfall of a key drug is undermining an international drive to reduce the malaria death toll. A rise in demand has led to a shortage of artemisinin, the main treatment for malaria that is resistant to conventional therapies, the World Health Organization (WHO) announced on 8 November.

Artemisinin is extracted from the wormwood plant, *Artemisia annua*, which grows wild in southern China and Vietnam. Combined with other drugs, its derivatives, such as artesunate and artemether, can clear symptoms of malaria in three days. Malaria currently kills about a million people every year, mainly in Africa.

In 2001, the WHO recommended that artemisinin-based combination therapies, or ACTs, should be used in countries where there is resistance to drugs such as chloroquine. Artemisinin-based drugs are more expensive than conventional treatments, in part because large doses are required.

The WHO reached a high-profile agreement with drug firm Novartis in 2001 for the company to supply one such ACT — artemether-lumefantrine (Coartem) — at cost price. In May this year, the Geneva-based Global Fund to Fight AIDS, Tuberculosis and Malaria took the further step of requiring all of its



Natural high: demand for products of the wormwood plant, which is used to make antimalarial drugs, has soared.

prepare. "Before June 2004, we never got a guarantee of a large order from Novartis," she says. The company is now ramping up production. A factory that can produce 20 tonnes of artemether a year — the full amount requested by Novartis — is due to open next autumn.

But manufacturing capacity only matters if the raw material is available. Increasing demand has pushed up the price and forced producers to use low-quality, low-yield leaves. Kunming Pharmaceutical will open its own plantation in February.

With production looking bleak for months to come, Bosman says that one of the greatest concerns is the further spread of ineffective fake ACTs. "This will feed a huge black market," she says.

Work is also under way to find varieties that grow well in local climates in Africa. Tanzania already has a promising variety and should be able to provide 20 tonnes by 2006, says Bosman.

Chemical fix

Long-term hopes are resting on the development of synthetic artemisinin-based drugs, which avoid the unreliability of cultivation. Scientists at the University of California, Berkeley, have created transgenic bacteria that can make a precursor to artemisinin. (V. J. J. M. *et al.*, *Nature*, 2004)

Estimated Demand
180 million doses of ACTs required

Total requirement= =27 tonne arteether == 54 tonne artemisinin
From 2400 ha cultivation for one ACT

For at least 10 ACTs
Potential 24000ha

Nature, Vol 432 , 18 November 2004, P259

Main producer China stopped exporting artemisinin and India is viewed as potential exporter

World market demand



आर्तेमिसिया जैव ग्राम मिशन का शुभारम्भ

LAUNCHING OF ARTEMISIA BIOVILLAGE MISSION

18 फरवरी, 2005



New drugs based on an old Chinese cure could save countless lives in Africa, if health agencies and companies can find ways to make enough

Enter *Artemisia annua* (also known as sweet wormwood or Qinghao), a shrub used for centuries in traditional Chinese medicine. In the 1970's, Chinese researchers discovered that its active ingredient, artemisinin, kills malaria parasites; since then, several chemical derivatives with slightly better properties have been developed. Known by names such as artemether or artesunate, they cure more than 90% of patients within several days, with few side effects observed so far. Best of all, no resistance has been seen yet. To keep it that way, WHO and others recommend that



But companies are reluctant to produce the drugs, as are farmers to grow *Artemisia*, without guarantees that they'll sell—and that's the problem. The Global Fund does not have

Ideally, 4 or 5 years from now, OZ will result in new drug combinations that have the power of current ACTs but cost less than a dollar per treatment, says Chris Hentschel, chief executive of the Medicines for Malaria Venture (MMV), a non-profit based in Geneva that supports its development. Still, Hentschel is trying to temper his optimism. Drugs can always fail during testing, and even ACTs may eventually lose their efficacy, like almost every malaria drug before. That's why, despite the new hope, MMV has its pipeline well-stocked with unrelated candidates.

Science, Vol 307
7 January 2005 p33

Taking New Challenges

- **End-to-end Mission**
- **Establishing Value Chain**
- **Cultivation to product to market**

Entrepreneurship

Mission mode approach for establishing value chain

Biovillages











It works



It works



It works



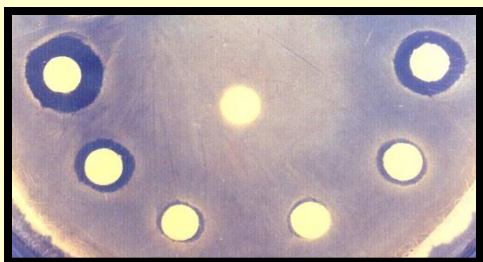
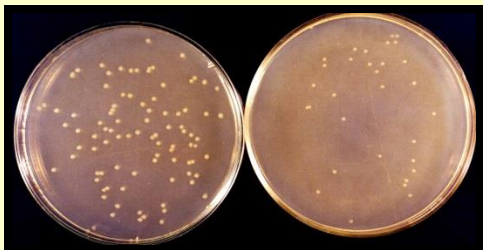
It works

It works

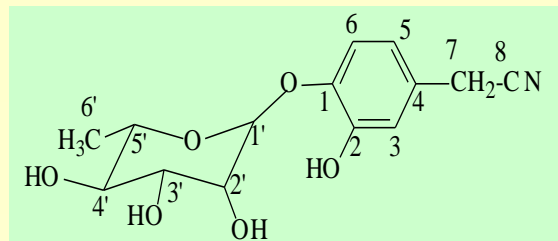


Bioenhancers

Bioenhancer molecules identified (2000-01)



In-vitro



Niaziridin

Niaziridin

2001-02

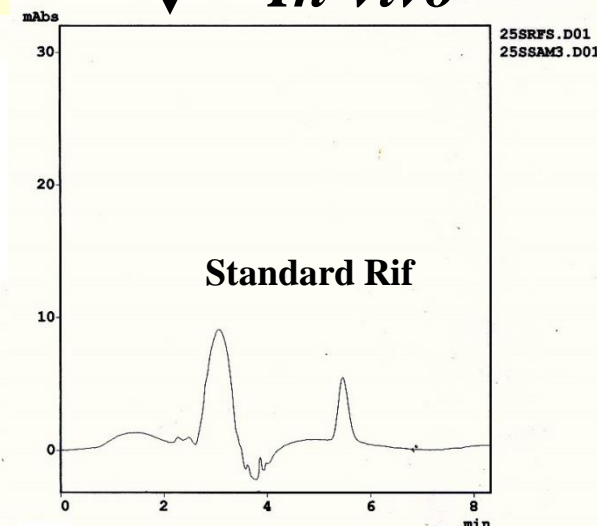
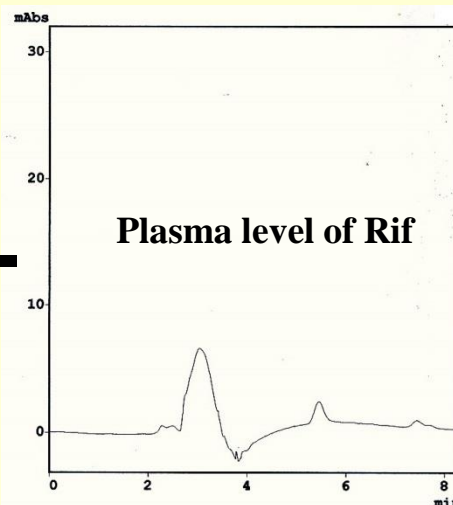


In-vivo

**Ready for
commercial
exploitation**

Toxicity
(acute)

2005-06

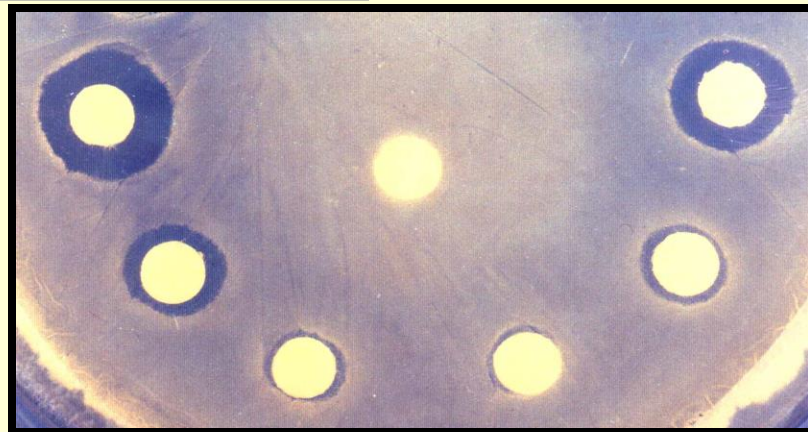
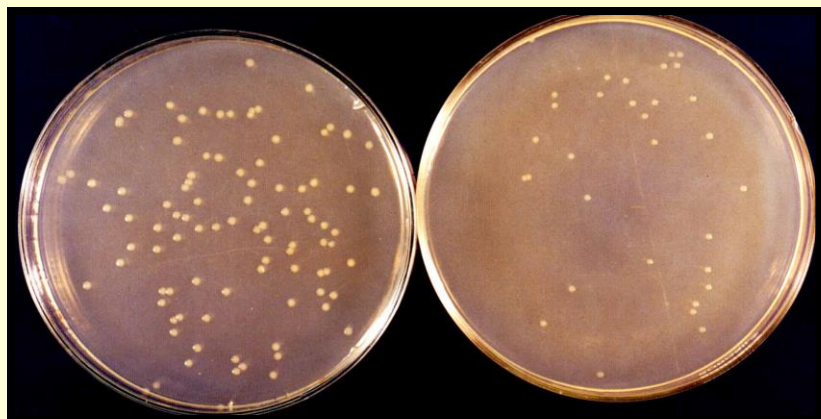


plasma level of rifampicin in rat model using HPLC method

Bioenhancing activity of pure compound CIM154 @ 0.1 ug/ml in combination with rifampicin and nalidixic acid against *E.coli* (CA8000)

Antibiotics ($\mu\text{g/ml}$)	Titre	% Survival	Fold enhancement in killing over antibiotic alone.
Control (LB)	1.1×10^8	100	
Rif (20)	1.5×10^4	0.0136	--
Rif (20)+CIM 154	3.9×10^3	0.0035	38.8
Rif (30)	3.8×10^4	0.038	--
Rif (30)+CIM 154	3.0×10^3	0.003	12.6
Control (LB)	6.0×10^8	100	
Nal (6)	6.0×10^6	1.0	--
Nal (6) + CIM 154	1.2×10^5	0.02	50.0

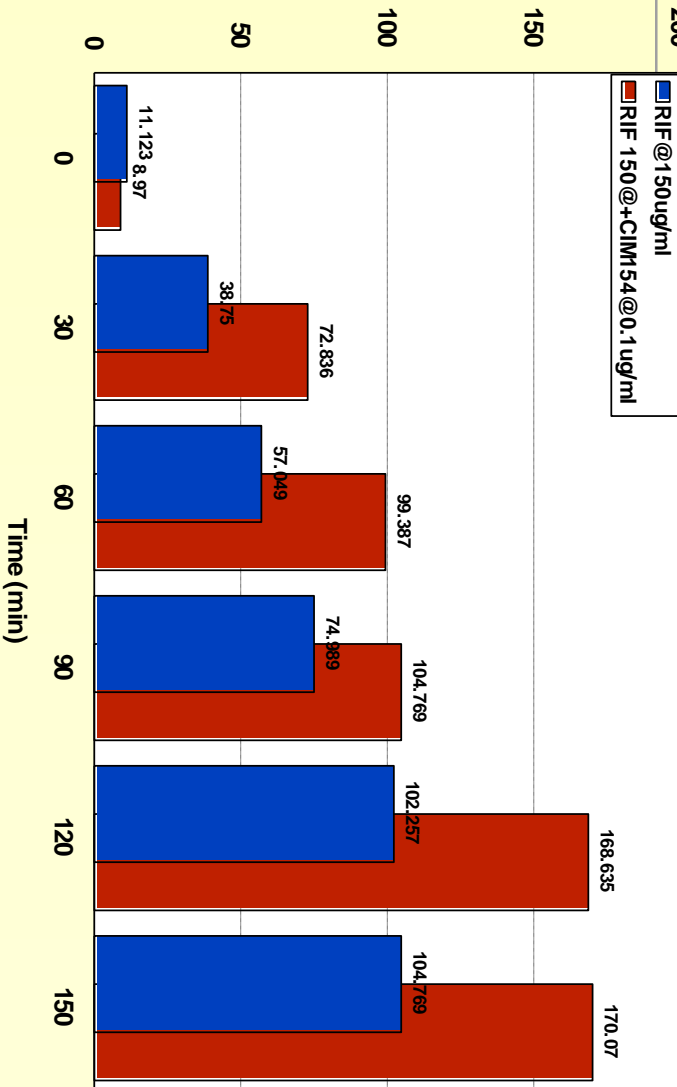
It works



Enhancement in rat intestinal mucosal permeability to rifampicin in presence of CIM 154 using 'everted sac' assay

It works

Rif (ug/ml)

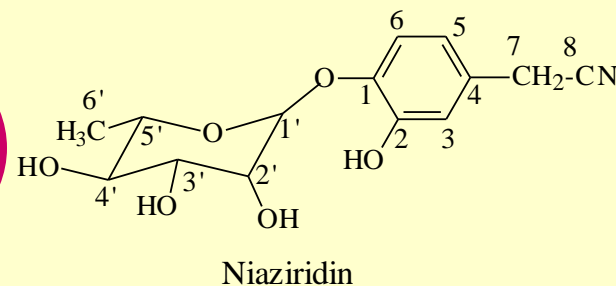


Time Interval (Minutes)	Rif @ 150 µg/ml	Rif +CIM 154 @ 0.1 µg/ml	Percent Enhancement
0	11.123 µg/ml	8.970 µg/ml	-
30	38.75 µg/ml	72.836 µg/ml	87.96
60	57.049 µg/ml	99.387 µg/ml	74.21
90	74.989 µg/ml	104.769 µg/ml	39.71
120	102.257 µg/ml	168.635 µg/ml	64.91
150	104.769 µg/ml	170.07 µg/ml	62.32

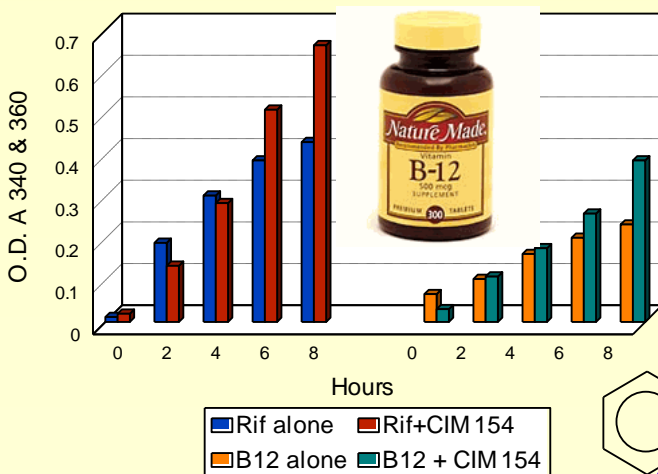


Antiinfective market (\$20B)
 Antibacterials 65%~\$13B
 10% of the market 130 million
 5 to 10 folds activity enhancement
 Net savings:104 to 117 million \$

CIM 154 Niazidirin (*Moringa oleifera*)



In-vitro bioavailability of rifampicin and
 vitamine B12 through gastro-intestinal
 membrane



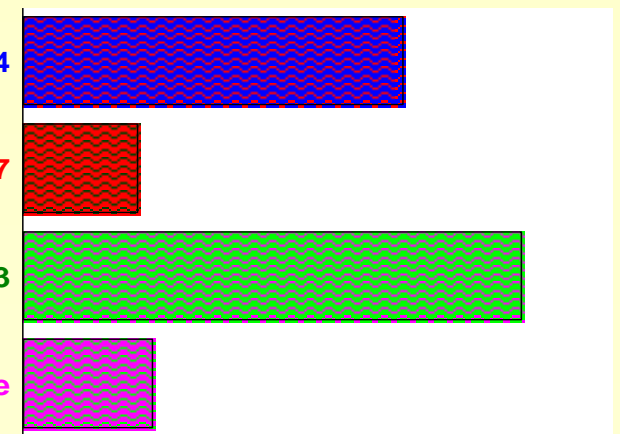
Bioenhancers

CIM 154

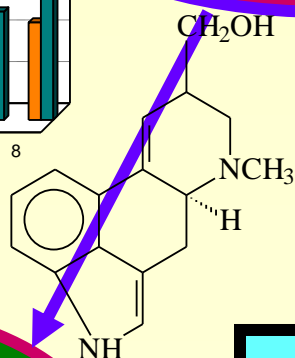
CIM 227

CIM 1843

Piperine

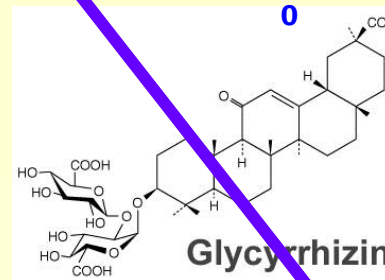


Fold enhancement



CIM 227 (Lysergol)
Ipomoea muricata

Niaziridin
 Lysergol
 Glycyrrhizin
 Lichesterinic acid
 CIM 1865 & CIM 1998
 Rose water components

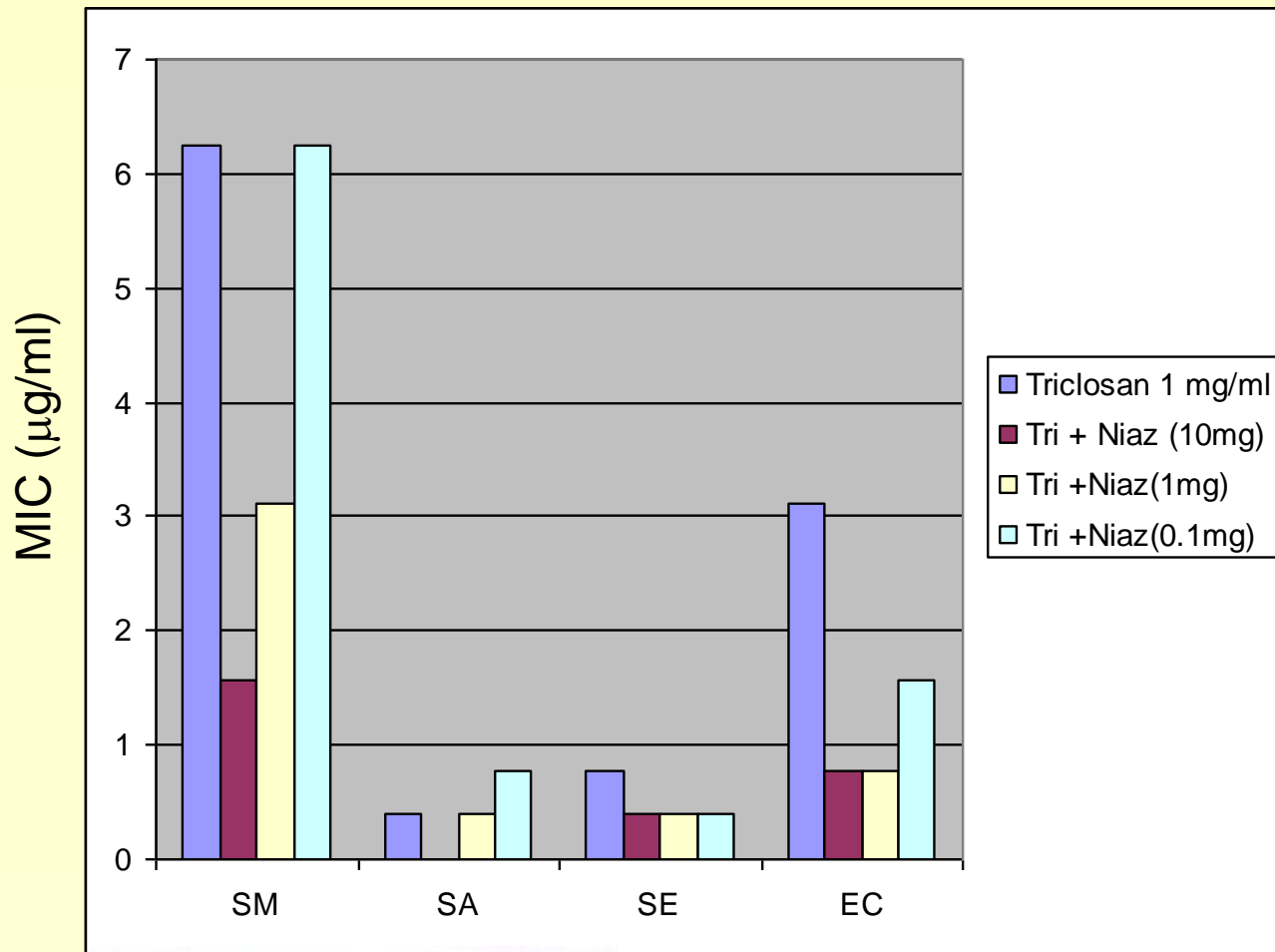


CIM 1843(Glycyrrhizin)
Glycyrrhiza glabra

It works

Reduction in MIC of Triclosan in presence of niaziridin

It works



Genetic screen based bioprospecting for antibacterials (2000-01)

It works

Drug resistance prevention system

**IDMA Patent Appreciation
Award for US Patent
No.6,423,741**
on
**“Antimicrobial composition
and the method for producing
the same”**

**from Indian Drug
Manufacturers Association,
Mumbai**

2005

113 His Pro His Gly Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 128 CA8000
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Ser Ala Val Tyr Asn Thr Ile Val Arg Met Ala 128 DH5α
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Ser Ala Val Tyr Asn Thr Ile Val Arg Met Ala 128 ET8000
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Ser Ala Val Tyr Tyr Thr Ile Val Arg Met Ala 128 CA8001
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Cys Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 128 CA8002
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Ser Ala Val Tyr Cys Thr Ile Val Arg Met Ala 128 CA8003
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Leu Ala Val Tyr Asn Thr Ile Val Arg Met Ala 128 CA8004
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

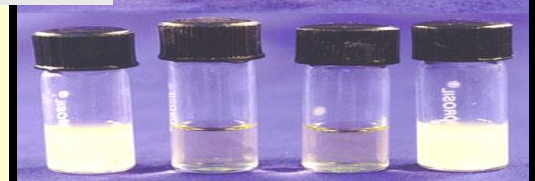
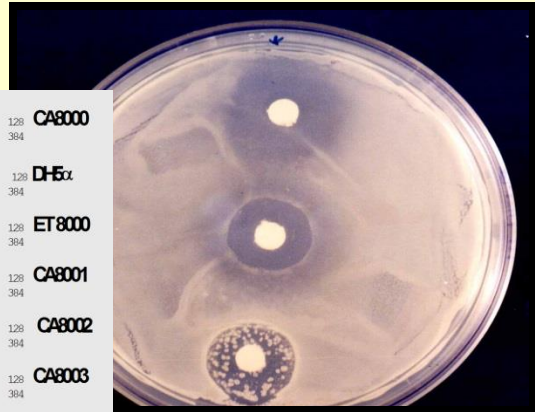
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113 His Pro His Gly Asn Leu Ala Val Tyr Asn Thr Ile Val Arg Met Ala 128 CA8006
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113 His Pro His Asp Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 128 CA8007
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Leu Ala Val Tyr Asp Thr Ile Val Arg Met Ala 128 CA8008
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384

113 His Pro His Gly Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 128 CA8009
337 CWT CXC CWT GGT GAC TGG GGG GGC TGT GAC AGG AGC GGC CXC ATG GGG 384



FFOODS – functional foods

In today's lifestyle driven society preventive healthcare through nutrition is becoming essential and the most acceptable way over the medicine route which has its own side effects and complexities related to bioavailability and biocompatibility..

It is in this scenario that functional foods and nutraceuticals area emerging as the choice of health-conscious populations

“Functional Food”

Typically a functional food encompasses all edible items having a health-promoting and / or disease-preventing property beyond the primary function of providing nutrients.

“Nutraceutical”

A nutraceutical is a product isolated / purified from foods and is normally available in medicinal forms that are not usually associated with food and possesses demonstrable physiological benefit / provides protection against chronic diseases.

Thus, functional foods are fast becoming a part of the meals with health benefits and better delivery.

New Frontier through Bio-horticulture

Interestingly vegetables and fruits or horticultural crops in general represent the best examples of edible plant harvest having functional food properties with a potential to develop nutritional ingredients or supplements. The perception of horticultural crops and products only as food, pulps and juices in various forms is now changing with developments in nutrition research. The chemistry of horticultural crops including edible and non-edible plant biomass is gaining importance for their metabolome capabilities to compete with conventional medicinal plants constituents for preventive health care

Khanuja SPS, Shukla AK (2011) Human health and nutrition: Functional foods. In: *Horticulture to Horti-Business* (Editors: KL Chadha, AK Singh, VB Patel), Proceedings Book of the Fourth Indian Horticulture Congress held at New Delhi during 18-21 November, 2010, Westville Publishing House, New Delhi, pp 433-445

Functional foods as the dietary components that provide health benefits beyond basic nutrition

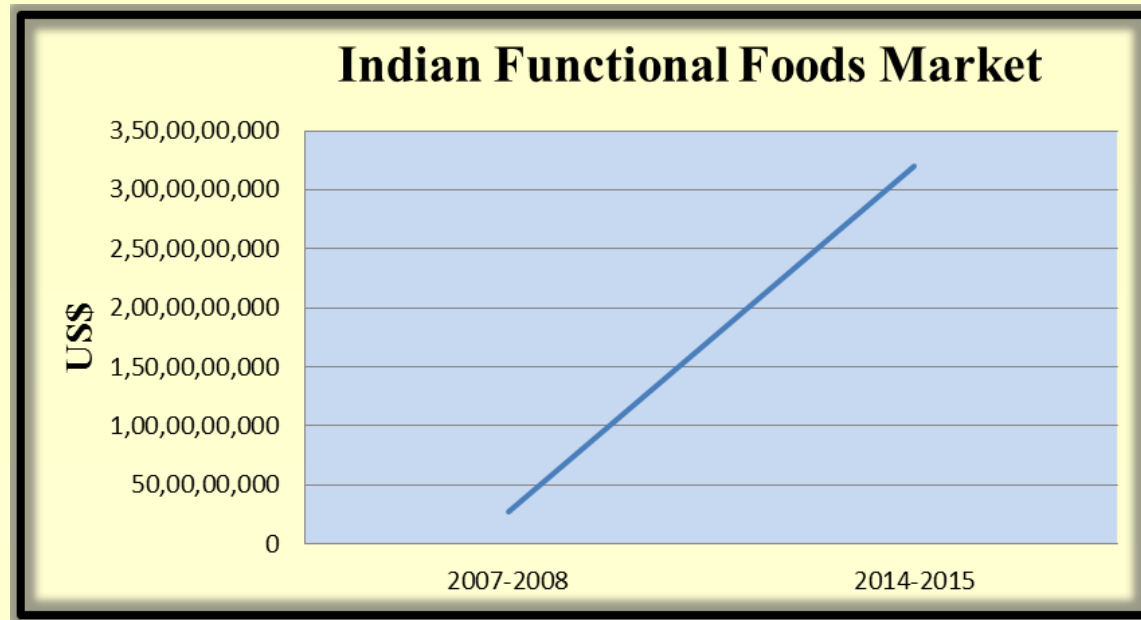
- **Carotenoids (like β -carotene, lutein, zeaxanthin, lycopene)**
- **Fiber (insoluble fiber, β -glucan, soluble fibres, whole grains)**
- **Fatty acids (mono-unsaturated fatty acids, poly-unsaturated fatty acids like omega-3-fatty acids, ALA, DHA, and conjugated linoleic acid)**
- **Flavonoids (anthocyanidins, proanthocyanidins, flavanones, flavonols, flavanols - catechins, epicatechins, procyanidins)**
- **Phenols (caffeic acid, ferulic acid)**
- **Plant stanols/sterols & polyols (sugar alcohols – xylitol, sorbitol, mannitol, lactitol),**
- **Prebiotic/probiotics (inulin, fructo-oligosaccharides, polydextrose, lactobacilli, bifidobacteria)**
- **Phytoestrogens (isoflavones, lignans)**

Designer functional foods

Vegetable matrices impregnated with bioactives

- **Functional foods** affect beneficially one or more target functions in the body, beyond adequate nutritional effects, to either improve stage of health and well-being and/or reduce the risk of disease.
- Development of functional fruit and vegetable matrices enriched with **bioactives, probiotics and minerals** (calcium and zinc).
- **Vacuum and/or atmospheric impregnation techniques** seem to be feasible technologies for exploitations of fruit and vegetable tissues as new matrices into which functional ingredients can be successfully incorporated, providing novel functional product categories and new commercial opportunities.

Alzamora et al, 2005. *Journal of Food Engineering* 67: 205-214



Source: Technopak

In India, the functional food industry has earned revenues of more than US \$ 265 million (Approx Rs 1,325 Crores) in 2007-08 and with an estimated growth rate of 43 %, it will reach US \$ 3.2 billion (Approx Rs 16,000 Crores) in 2014-15. (Source: Technopak)

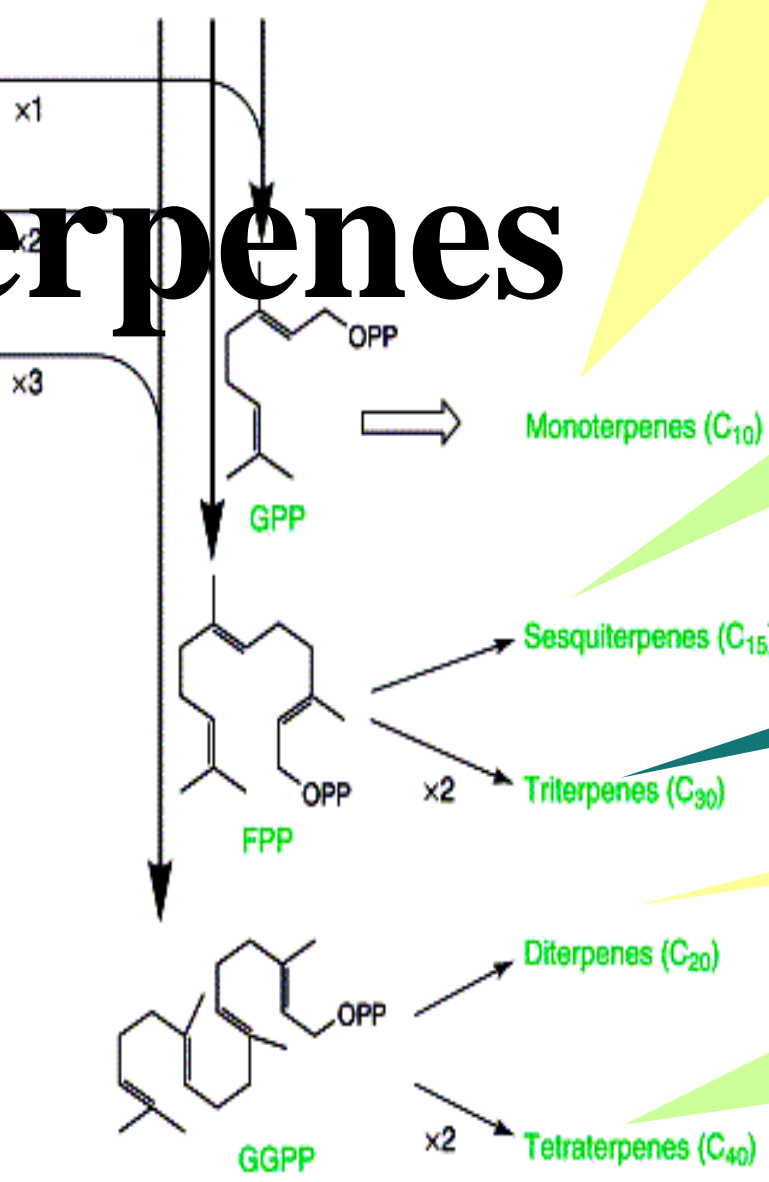
In India, functional foods are therefore expected to see increased consumption over the next five years resulting in functional foods and beverages garnering greater product share in the market as opposed to dietary supplements (Source: Frost & Sullivan)

Chemistry of Agri-produce determines the value...

Secondary Agriculture



Terpenes



22000 described

Mentha species, Cymbopogon Species, Ocimum Species, Pelargonium species, Clarkia breweri, Petunia etc

Sesquiterpene lactones (SL's) of which over 3000 have been described, mostly in the Asteraceae (daisy) family

Artemisia annua, Pyrethrum, Chicory, Tulip, Tagetes, Sage, cotton, Tansy, Yarrow, Chamomile, Arnica etc

Bacopa monnieri, Centella asiatica, Coccinia indica, Lagerstroemia speciosa, Annona cherimola, Nigella sativa, Oenothera biennis, Salvia officinalis, Morus alba, Fagopyrum esculentum, Ocimum basilicum, Zea mays, Glycyrrhiza glabra, Commiphora

Stevia rebaudiana, Tinospora cordifolia, Panax notoginsang etc

Morinda citrifolia, Luffa aegyptiaca, Mimosa pudica, Spinacia oleracea, Daucus carota, Capsicum annuum, Ipomoea batatas, Brassica nigra, Beta vulgaris

Ingro Potrykus and Peter Beyer



geranylgeranyl-PP



phytoene synthase

phytoene + 2 pyrophosphate



crt1

zeta-carotene



crt1

lycopene



alpha-carotene



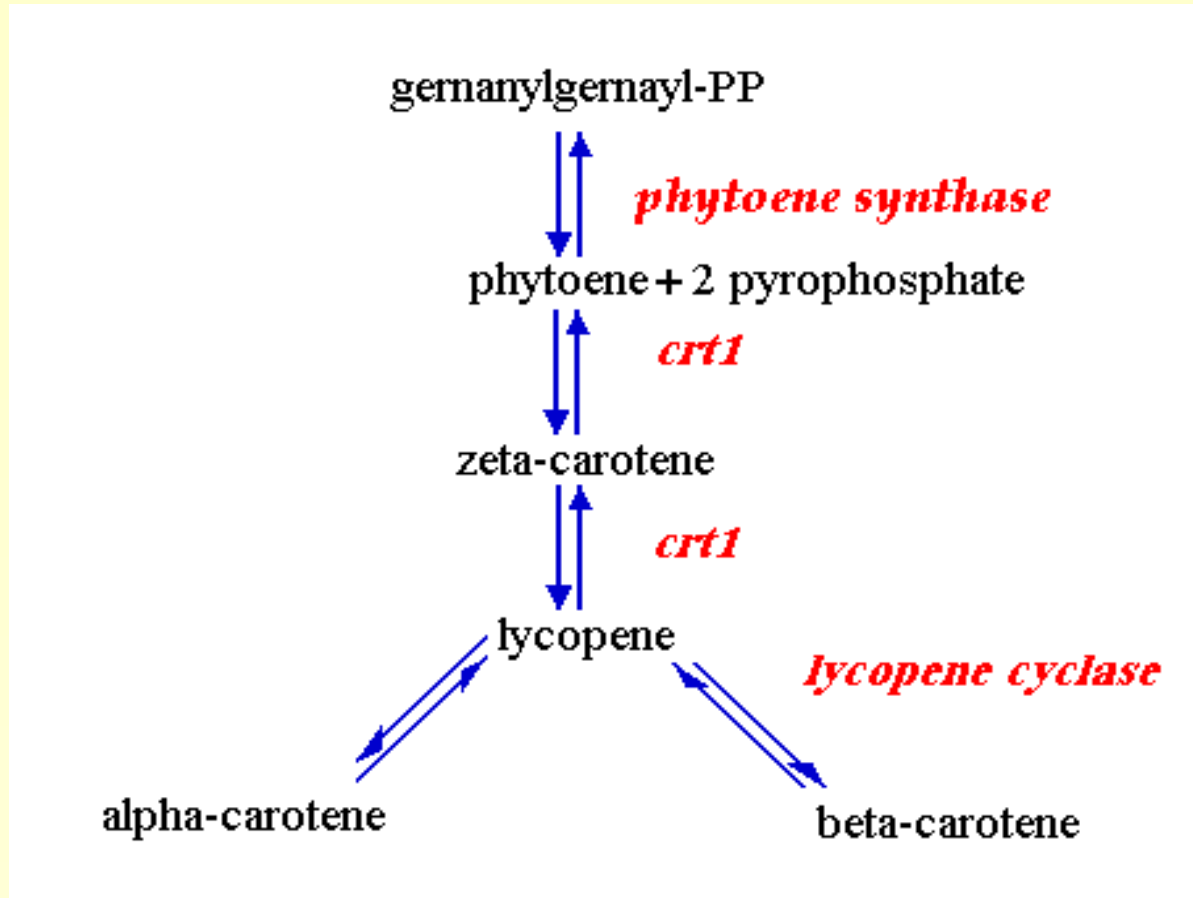
beta-carotene

lycopene cyclase

***psy* (phytoene synthase) & *lyc* (Lycopene cyclase)
both from Daffodil (*Narcissus pseudonarcissus*)
crt1 from the soil bacterium *Erwinia***

***Science* 2000. 287 (5451): 303-305**

Golden Example of Terpenoid Pathway use in Food Crop: Rice for Vitamin Fortification plus...



Think beyond: Horti Rice !!
Tomato.... Moringa.... Carrot....

Sulforaphane

Plant Source: Broccoli

Nutritional Potential / Use:

Stimulant for enzymes that detoxify
chemical carcinogens



R & D Challenge / Scope:

The trait has been selectively bred out of commercial
broccoli because of its bitter taste

Dietary Fiber

Plant Source:

Avocado, Oat, Flax, Chia, Whole grains, Cranberry



Salvia
hispanica
2mm long



Nutritional Potential / Use:

Essential dietary ingredient but average consumption is only 14-15g daily against the RDI of 38 grams

R & D Challenge / Scope:

Fiber content needs to be enhanced in food items for optimum fiber diet that can be RDI equivalent

Omega-3 fatty acids

Plant Source:
Chia, Flax, Soy



Nutritional Potential / Use:

Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA) are made by seawater microalgae, which in turn is consumed by fish that accumulate these fatty acids. Therefore source is mainly fish or rarely microalgae but not plants.

R & D Challenge / Scope:

Plant sources normally contain only alpha linolenic acid (ALA) and lack the more healthful DHA and EPA. Strategic breeding and biotech interventions are required so that DHA and EPA, can be produced directly from microalgae or designer plants

Peptides

Plant Source:

Wheat germ, Spinach

Nutritional Potential / Use:

Certain food-derived peptides lower blood pressure by inhibiting angiotensin-converting enzyme (ACE)



R & D Challenge / Scope:

Most horticulture sources are not even explored for such peptides

Calcium fortified food

Plant Source:

Soybean, Peanuts, Pea etc



Nutritional Potential / Use:

Soy milk fortified with calcium is the option for people suffering from milk allergy due to lactose intolerance



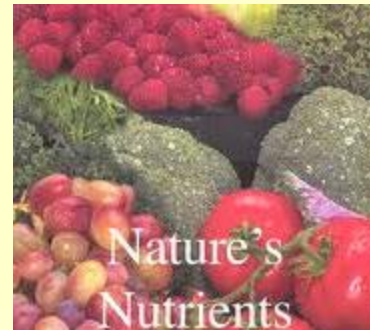
R & D Challenge / Scope:

Taste acceptability demands improvement. Similarly bioavailability of calcium (vis-à-vis cow milk) and need of alternate sources can be visualized

Vitamins and Minerals

Plant Source:

Most fruits and vegetables



Nutritional Potential / Use:

Nutritional deficiencies arising out of geographical and regional variation in horticulture crop production patterns can be managed through functional foods



R & D Challenge / Scope:

Identification of synergistic interactions that enhance accessibility, bioavailability and biological potency is desirable

β -carotene

Plant Source:

Carrot, Moringa, GM rice



Nutritional Potential / Use:

Golden Rice developed by transforming rice with three genes: phytoene synthase (psy) and lycopene cyclase (lyc) from daffodil (*Narcissus pseudonarcissus*) and crt1 from the soil bacterium *Erwinia uredovora*. In Golden Rice 2, psy gene from maize was used with crt1 from the original golden rice to get a higher carotenoid content

R & D Challenge / Scope:

Technology could not be commercialized effectively beyond proof-of-concept stage due to large dietary requirements of the fortified rice.

Sources like Moringa offer non-GM sources that are edible and cultivable both and have no safety risks or toxicity

Alpha-carotene from veggies linked to longer life

By [Katherine Harmon](#) | Thursday, December 30, 2010 | [6](#)



The team found an especially strong correlation between higher alpha-carotene levels and lower risk of death from [diabetes](#), upper respiratory tract and upper digestive tract cancers, as well as lower respiratory disease.

Unlike beta-carotene, alpha-carotene is not often found in multivitamins or other [common dietary supplements](#), which suggests that most of the quantities found in people's blood comes from food (primarily yellow-orange and [dark green veggies](#), including [broccoli](#), [carrots](#), collards, green beans, lettuce, peas, [pumpkin](#), spinach, sweet potatoes and winter squash). And a previous case-control study found that eating more of these sorts of alpha-carotene-rich veggies led to a decreased risk of lung cancer.

Annona squamosa (Annonaceae)

Atis / Custard apple

Major volatile constituents of *A. squamosa* L. bark

1H-cycloprop(e)azulene (3.46%)
germacrene D (11.44%)
bisabolene (4.48%)
caryophyllene oxide (29.38%)
bisabolene epoxide (3.64%)
kaur-16-ene (19.13%)

Annonaceous acetogenins have also been isolated from *A. squamosa* seeds. **Squamotacin** showed cytotoxic selectively for the human prostate tumor cell line (PC-3).



Medicinal Uses

- ❖ The leaves serve as a purgative.
- ❖ Bark decoction is used to stop diarrhea.
- ❖ Decoction of the leaves and/or root is taken in cases of dysentery.
- ❖ Decoction of the leaves is good to cure diabetes.
- ❖ The leaves are applied to abscesses and open wounds and used to cure skin itches.
- ❖ The crushed leaves are sniffed to overcome fainting spells and hysteria,
- ❖ The mashed, ripe fruit, mixed with salt, is applied on tumors.
- ❖ Decoction of the leaves is used to aid digestive problem, and to treat colds.
- ❖ Decoction of the leaves is employed in baths to alleviate rheumatic pain
- ❖ Decoction of the leaves is used to clarify urine.
- ❖ The seeds immersed in coconut oil is a traditional treatment for head and body lice. The seed is also made into powder and can be applied on head to kill lice in hair.

It is high in calories and is a good source of iron. The fruits contain no sodium, they are high in carbohydrates and rich in calcium, vitamin C and phosphorus, and with a sugar content of about 50-50 (glucose and sucrose). The roots of the sugar apple tree are powerful enough to induce abortions.

Prebiotics

Plant Source:

Jerusalem artichoke, jicama chicory root, soybean, onion, garlic, raw oats, unrefined wheat, unrefined barley and yacon



Nutritional Potential / Use:

Non-digestible food components (oligofructose and inulin) stimulating the growth and / or activity of bacteria in the digestive system, which in turn benefit body health

R & D Challenge / Scope:

Some people suffer from fructose malabsorption, excess dietary intake of inulin (a fructan) may lead to minor side effects, like increased flatulence and loose stools. Better formulation required to overcome this

Punica grantum



239 Nucleotides

No EST

31 Proteins

In human pilot studies, juice of the pomegranate was effective in reducing heart disease risk factors, including LDL oxidation, macrophage oxidative status, and foam cell formation, all of which are steps in atherosclerosis and cardiovascular disease.

- Pomegranate aril (seed casing) juice provides about 16% of an adult's daily **vitamin C** requirement per 100 ml serving, and is a good source of **vitamin B5** (pantothenic acid), **potassium** and antioxidant **polyphenols**.
- The seeds also supply fibre and unsaturated oils.
- The most abundant polyphenols in pomegranate juice are the hydrolyzable tannins called **ellagitannins** formed when **ellagic acid binds** with a **carbohydrate**.
- **Punicalagins** are unique pomegranate tannins with free-radical scavenging properties.
- During intestinal metabolism by bacteria, ellagitannins and punicalagins are converted to **urolithins** which have unknown biological activity *in vivo*.
- Other phytochemicals include **polyphenolic catechins**, **galocatechins**, and **anthocyanins**, such as **prodelphinidins**, **delphinidin**, **cyanidin**, and **pelargonidin**.

Botanical Berries

- The botanical definition of a berry is a fleshy fruit produced from a **single ovary**.
- A plant that bears berries is said to be **bacciferous**.
- The berry is the most common type of fleshy fruit in which the **entire ovary wall ripens** into an edible pericarp.

Oxygen Radical Absorbance Capacity (ORAC)

- A method of measuring antioxidant capacities in biological samples *in vitro*.
- Spices, berries and legumes are rated highly.
- In nearly all vegetables, conventional boiling can reduce the ORAC value by up to 90%, while steaming retains more of the antioxidants.

The good nutrient content and high ORAC distinguishes several berries within a new category of functional foods called "superfruits".



Bearberry (*Arctostaphylos* spp.)
Barberry (*Berberis*; Berberidaceae)
Crowberry (*Empetrum* spp.)
Currant (*Ribes* spp.)
Elderberry (*Sambucus niger*)
Gooseberry (*Ribes* spp.)
Grape, (*Vitis vinifera*)
Honeysuckle (*Lonicera* spp.)
Lingonberry (*Vaccinium vitis-idaea*)
Mayapple (*Podophyllum* spp.)
Nannyberry (*Viburnum* spp.)
Oregon-grape (*Mahonia aquifolium*)
Strawberry Tree (*Arbutus unedo*)
Tomato (*Solanum lycopersicum*)
Watermelon (*Citrullus lanatus*)
Cranberry (*Vaccinium* spp.)

Vitis vinifera

Wine Grapes



A grape is a **non-climacteric** fruit. It can be eaten raw or used for making jam, juice, jelly, vinegar, wine, grape seed extracts, raisins, and grape seed oil. It is also used in some kinds of confectionery.

113676 Nucleotides

362193 ESTs

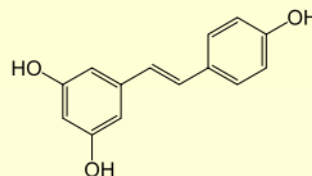
76179 Proteins

• Approximately 71% of world grape production is used for wine, 27% as fresh fruit, and 2% as dried fruit. **India was ranked 10th** among the highest grape producing countries of the world in 2009.

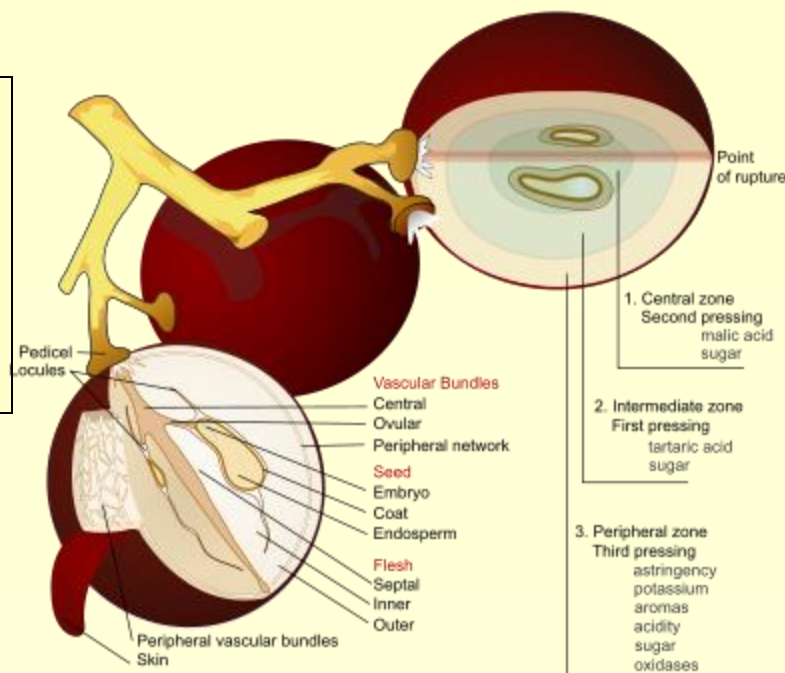
French Paradox

Although the French tend to eat higher levels of animal fat, the incidence of heart disease remains low among them due to protective benefits of regularly consuming **red wine**. Apart from potential benefits of alcohol itself, including reduced platelet aggregation and vasodilation, polyphenols (like **resveratrol**) in the grape skin provide other health benefits.

Trans-Resveratrol



(3,4',5-trihydroxystilbene) - a stilbenoid



Other Grape Constituents

- **Anthocyanins** tend to be the main polyphenolics in purple grapes whereas **flavan-3-ols** (e.g., **catechins**) are the more abundant phenolic in white varieties.
- The flavonols **syringetin**, **syringetin 3-O-galactoside**, **laricitrin** and **laricitrin 3-O-galactoside** are also found in purple grape but absent in white grape.
- Seeds contain oligomeric proanthocyanidins. Together with **tannins**, **polyphenols** and **polyunsaturated fatty acids**, these seed constituents display inhibitory activities against several experimental disease models, including **cancer**, **heart failure** and other **disorders of oxidative stress**.
- Grape seed oil from crushed seeds is used in **cosmeceuticals** and **skincare products** for many perceived health benefits. Grape seed oil is notable for its high contents of tocopherols (**vitamin E**), **phytosterols**, and **polyunsaturated fatty acids** such as **linoleic acid**, **oleic acid** and **alpha-linolenic acid**.

Citrullus lanatus

Watermelon



349 Nucleotides 8584 ESTs 251 Proteins

- A watermelon contains about 6% sugar and 92% water by weight.
- As with many other fruits, it is a source of **vitamin C**.
- Contains large amount of amino acid **citrulline**, **lycopene** and **beta-carotene**.
- Seed is **demulcent**, **diuretic**, **pectoral** and **tonic**. It is also used to treat treat bed wetting and is also a good vermifuge.
- A fatty oil in the seed, as well as aqueous or alcoholic extracts, **paralyze tapeworms** and **roundworms**.
- The fruit is used as a febrifuge. It is also diuretic, being effective in the treatment of **dropsy** and **renal stones**. It contains lycopene.

Musa spp.

Banana



4591 Nucleotides 31314 ESTs 2793 Proteins

- Bananas come in a variety of **sizes and colors** when ripe, including yellow, purple, and red.
- Staple **starch** of many tropical populations.
- Reduce the risk of **colorectal cancer**, **breast cancer** and **renal cell carcinoma**.
- Individuals with a **latex allergy** may experience a reaction to bananas.
- Contain considerable amounts of **vitamin B6**, **vitamin C**, and **potassium**. The latter makes them of particular interest to athletes who use them to quickly replenish their **electrolytes**.
- In India, juice is extracted from the corm and used as a home remedy for **jaundice**, sometimes with the addition of honey, and for **kidney stones**.
- India is the top banana producing country of the world.

Solanum lycopersicum

Tomato



127700 Nucleotides 298229 ESTs 5821 Proteins

1 Genome Sequence

- They contain **lycopene**, one of the most powerful natural antioxidants. It is found to prevent **prostate cancer** and enhance the skin's ability to protect against harmful UV rays .
- Tomato varieties are available with double the normal vitamin C (**Doublerich**), 40 times normal vitamin A (**97L97**), high levels of anthocyanin (**P20 Blue**), and two to four times the normal amount of lycopene (numerous available cultivars with the **high crimson gene**).
- Its consumption has been associated with decreased risk of breast cancer, head and neck cancers and might be strongly protective against neurodegenerative diseases.
- Green unripe fruit of the tomato plant contain small amounts of the poisonous alkaloid **tomatine**.
- Tomatoes have been linked to seven **salmonella outbreaks** since 1990.

Capsicum annuum

Capsicum

1628 Nucleotides 118060ESTs 1283 Proteins

- Despite being a single species, *Capsicum annuum* has many cultivars, with a variety of names.
- **Capsaicin** and several related compounds are called **capsaicinoids** and are produced as a secondary metabolite by chili peppers, probably as deterrents against certain herbivores and fungi
- Capsaicin, creates a burning sensation once ingested.
- It is a potential inhibitor of cholera toxin production in *Vibrio cholerae* (Chatterjee et al 2010).
- It is currently used in topical ointments, as well as a high-dose dermal patch (trade name **Qutenza**), to relieve the pain of peripheral neuropathy such as post-herpetic neuralgia caused by shingles.
- Capsaicin creams are used to treat **psoriasis** as an effective way to reduce itching and inflammation



- Capsaicin may help treat ear infections such as **otitis**.
- Also the active ingredient in riot control and personal defense **pepper spray** chemical agents.
- Acts as a **pest deterrent**.

Supplement Produces a 'Striking' Endurance Boost



ScienceDaily (Aug. 26, 2010) — Research from the University of Exeter has revealed taking a dietary supplement to boost nitric oxide in the body can significantly boost stamina during high-intensity exercise.

Beets. Taking a dietary supplement to boost nitric oxide in the body can significantly boost stamina during high-intensity exercise. Earlier research showed that the high nitrate content of beetroot juice, which also boosts nitric oxide in the body, has a similar effect on performance. (Credit: iStockphoto/Joe Biafore)

Allium sativum, Alicin (Diallyl thiosulfinate)



Aged garlic shows blood pressure improvement benefits:
Study By Stephen Daniells, 17-Nov-2010

Daily supplements of an aged garlic extract may reduce systolic blood pressure by 10.2 mmHg, suggests new data from Australia.

Writing in *Maturitas*, scientists from the University of Adelaide report that the benefits were only observed in people with initial systolic pressure (SBP) of 140 mmHg or over, and that no effects were observed in people with lower SBP.

“Aged garlic extract is regarded as safe and more tolerable than garlic powder, and superior to raw or cooked garlic in relation to its antihypertensive properties,” explained the researchers. “In addition, the active component S-allylcysteine (SAC) in AGE is less volatile than allicin in garlic powder, and therefore more easily standardised.”



SUMAN KHANUJA INNOVATION ENTERPRISES

Research Centre at Biotech Park Lucknow

National Technology
Day: 11th May 2012



SKiES Life Technologies (P) Ltd

Bringing nature to life

www.skiesindia.com



Vision: *Constructing the science driven industrial path of translating traditional agriculture and natural biodiversity knowledge into high value products employing technological innovations for integrating life sciences, chemistry and engineering for sustainable bioharvests on eco-compatible business mode.*

Mission: *To evolve as the technology gateway and industrial innovation hub delivering sustainable technologies, products, services and business alliances in the sectors of agribiotech, nutraceuticals, health foods & supplements, bioactive ingredients, botanicals and natural products from flora and fauna.*

Aim: *Science and innovation driven translational research to enhance the industrial value of flora-fauna produce and products making business of botanicals and agriculture happen sustainably on a commercial scale. Simultaneously also providing "entrepreneur shaper" platform to mentor out-of-box creative ideas in agriculture and biotechnology including natural products to take off as micro or small industrial startups and novel products for farm and pharma.*

3rd May 2013

YoFi Protein & Fibre full Prebiotic Chocolate

Yogurt, the Yo, is an excellent source of protein better than milk not only in quantity but also more importantly the quality. Since yogurt is made with live and active lacto-cultures, it is now a healthy lifestyle favourite. Quality! Because the microbial culturing of the milk proteins during fermentation in yogurt preparation makes these proteins easier to digest. Such proteins are also referred as "pre-digested." like honey is for the carbohydrates!!

Caseins, are the major group of milk proteins that coagulate in yogurt, having the most appropriate amino acid composition for growth and development of the young. Caseins are highly digestible in the intestine and this wonderful quality of these proteins in cattle milk makes it such an important human food. Coagulated casein in yogurt is rich source of amino acids and two important inorganic elements, calcium and phosphorus. Yo, the first value part of YoFi bar is yogurt contributing these nutritious and so easily digestible proteins.

Fibre, the Fi, is the second value part of YoFi bars. Nutritionists recommend 25 to 38 grams of fibre every day and obviously it is not possible to get it from one meal or one source. Best way is to supplement a portion of fibre from a dessert product like chocolate! Although not an energy source for humans, fibre is an important dietary aid that makes the gut healthy, metabolism strong and prevents many diseases or disorders like it can decrease cholesterol levels, help to reduce the risk of heart disease and even help control blood sugar levels.

YoFi gets this from Fenugreek (*Trigonella foenum-gracium*) or traditionally called "Methi" in India which is a leguminous herb possessing wonderful medicinal and spice value. Fenugreek seeds offer the richest source of both soluble and insoluble fibre. The whole seed powder has a bitter taste and odour due to certain constituents, present in its germ portion but not due to its polysaccharide. Purified fenugreek oligosaccharide gum used in this YoFi bar is a completely odourless and tasteless ingredient making the chocolate taste as it should!



Most desirably the fenugreek gum thickens the ingested food to form a gel in stomach trapping fat, sugars and starch hydrolysing 'amylase' enzyme to slow down sugar absorption.

Wow! YoFi bar has Yo (Yogurt) joining the Fi (Fiber) for the gut bringing a smiling life with guts !!



YoFi is wonder of deep scientific functional food research combining taste with nutrition having most digestive proteins with soluble fibre, a necessity of metabolism and healthy life. And that too is in a "GenY" taste format of a chocolate bar that has added value of the prebiotic potential too for making all probiotic supplements effective which we take for gut health by helpful microbes that sustain life!!

What next? YoFi is appearing in deep (Dark chocolate), light (Milk chocolate) and white (Milky bar) choices for adults, teens and children while seniors have all for them too with less sugar and fat. It is for everyone whether you like classic chocolates or you like mild or light.

SKiES Life Technologies Pvt. Ltd.

Bringing nature to life

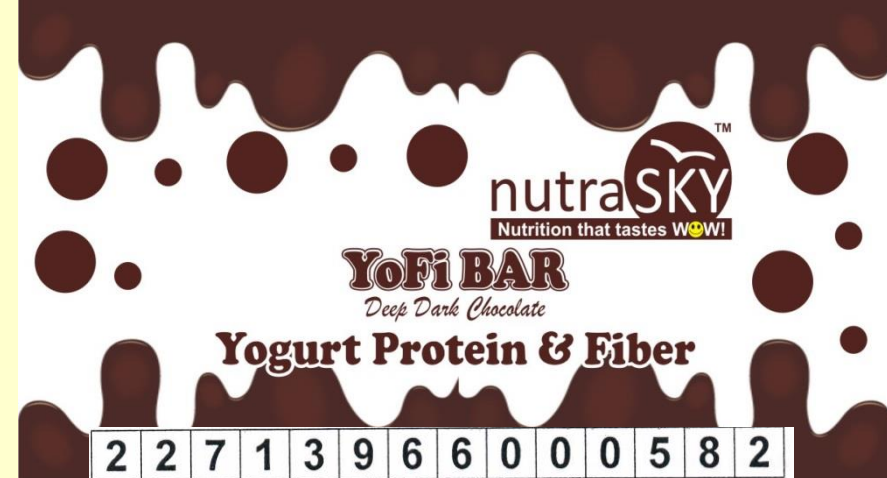
Research & Development : SKiES Lab, Biotech Park, Kursi Road, Lucknow 226021, UP, INDIA
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**YOGURT
PROTEIN
FIBER**

FSSAI Registration

2nd July 2013





Suman Khanuja Innovation Enterprises

Bringing nature to life



SKiES Entrepreneur Enabler (SEE 2013-14)

As its Pioneering Human Resource (HR) Service Initiative

SKiES Entrepreneur Enabler (SEE 2013-14)

Suman Khanuja Innovation Enterprises (SKiES) is industrial biotech R&D-cum-product innovation enterprise working on improvising and developing technologies and products while also extending scientific and technical services including consultancy and IPR Management independently as well as through business alliances in the biotechnology sector covering areas of agribiotech, post-harvest technology, food biotech (health foods, dietary ingredients, nutritional supplements, functional foods, nutraceuticals), bioactives and molecules (pharmaceutical and medicinal active ingredients), aromas, veterinary health care products, biotech processes for manufacturing microbial/animal/plant products including natural and value added products from flora, fauna and agriculture produce.

Announcement BIOTECH TRAINING PROGRAMME 2013 - 2014

SKiES Research Centre
BIOTECH PARK,
LUCKNOW

SKiES offers sector specific industrial and agro -biotech training modules

- Speciality industrial (agriculture, food and health) biotech skill developer
- Bio-entrepreneurial opportunities enhancer
- Self-employment biotech capabilities generator

The training modules offer intensive industrial skill development exposure in specialised areas of agribiotech, plant biotech, food biotech, medicinal and aromatic plants, natural products, functional foods, nutraceuticals, and bioactives for pharma and agro applications. The objective is to fill gap between formal science and engineering education and industrial needs in human resource as super-skilled manpower in biotech and life-technologies sector.

Beneficiary recipients who can avail this unique "hands-on-minds-in" skill creation exposure through SKiES can be students, industrial interns, researchers, industries, finishing schools, institutions and individuals with specific skill needs from these areas. The trainees can be from all streams of life sciences, biotechnology, agriculture, natural products chemistry and allied engineering and technology fields

For sponsors: The training modules will be available in *ready-to-go* as well as *custom-made* fashion to suit trainees' and sponsors' requirements.

The SKiES program offers module of two/three months each or six-twelve months packages depending on the skill need and levels. It will involve laboratory work, techniques and methods on analytical instrumentation, field/industry visits and short term projects along with industrial process optimization in lab and floor with direct "hands-on-minds-in" exposure. The fee structure for the "ready-to-go" modules is as follows

S.NO.	MODULES	TIME DURATION	FEE (INR)*
1	Module Level 1	Two months	12,000
2	Module Level 2	Three months	15,000
3	Package Level 1	Six months	24,000
4	Package Level 2	Twelve months	40,000

* Service tax to be paid to the government will be additional as per actuals (Currently 12.36%)

- Level 1 is meant for a fresher taking technology entrepreneurial training for the first time while Level 2 is for those who have initial exposure and are ready to take up project mode training.
- Full package, however is recommended, if process-to-product exposure is desired with quality analytical skills backup.
- Travel involved for visit to outside industry and fields will have to be borne by candidates. (special support will be given to candidates showing outstanding performance.
- Special support in form of a stipend to reduce fee payable will be available to extra-meritorious candidates with outstanding performance during the training period in package formats.



Suman Khanuja Innovation Enterprises

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Acknowledgement...



Team CIMAP (CSIR)

The green path to better health & life

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Best of Learning !

SUMAN KHANUJA INNOVATION ENTERPRISES
SKiES Life Technologies Pvt. Ltd.

Bringing nature to life

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