

# Reaching the unreached

## The innovation path of converging sciences into business

**Suman PS Khanuja**  
Director

**SKiES Life Technologies Pvt. Ltd.**

*Bringing nature to life*

???

**Not to follow**

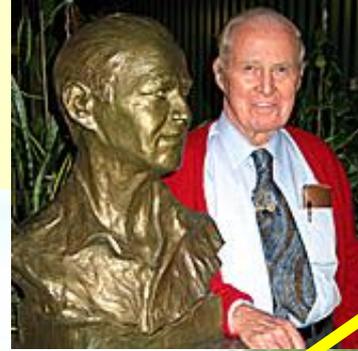
**Innovate**

**Tall grows to dwarf**

**Innovate**

# Evolution of Agriculture

10000	8000	2500	1 AD	500	1000	1500	1700	1800	1900	1960	1990
Prehistory											
Agricultural Revolution											
Historical Agriculture											
Feudal Agriculture											
Scientific Agriculture											
										Green Revolution	



**Dwarf gene**  
Dee geo woo ger

**Green Revolution**

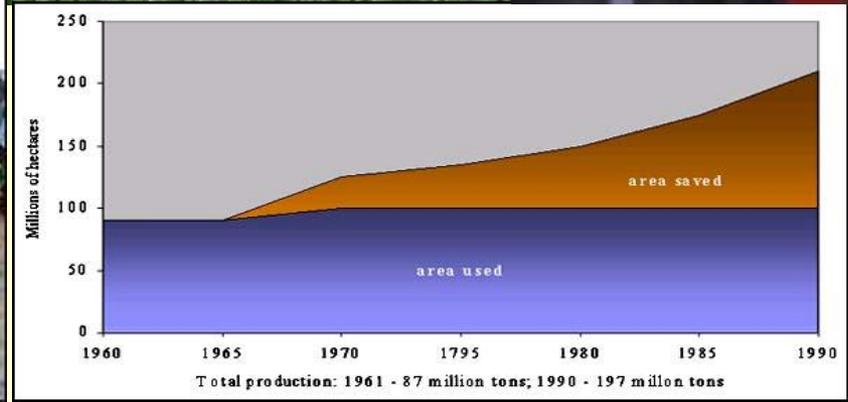


## Hybridization

## 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**"

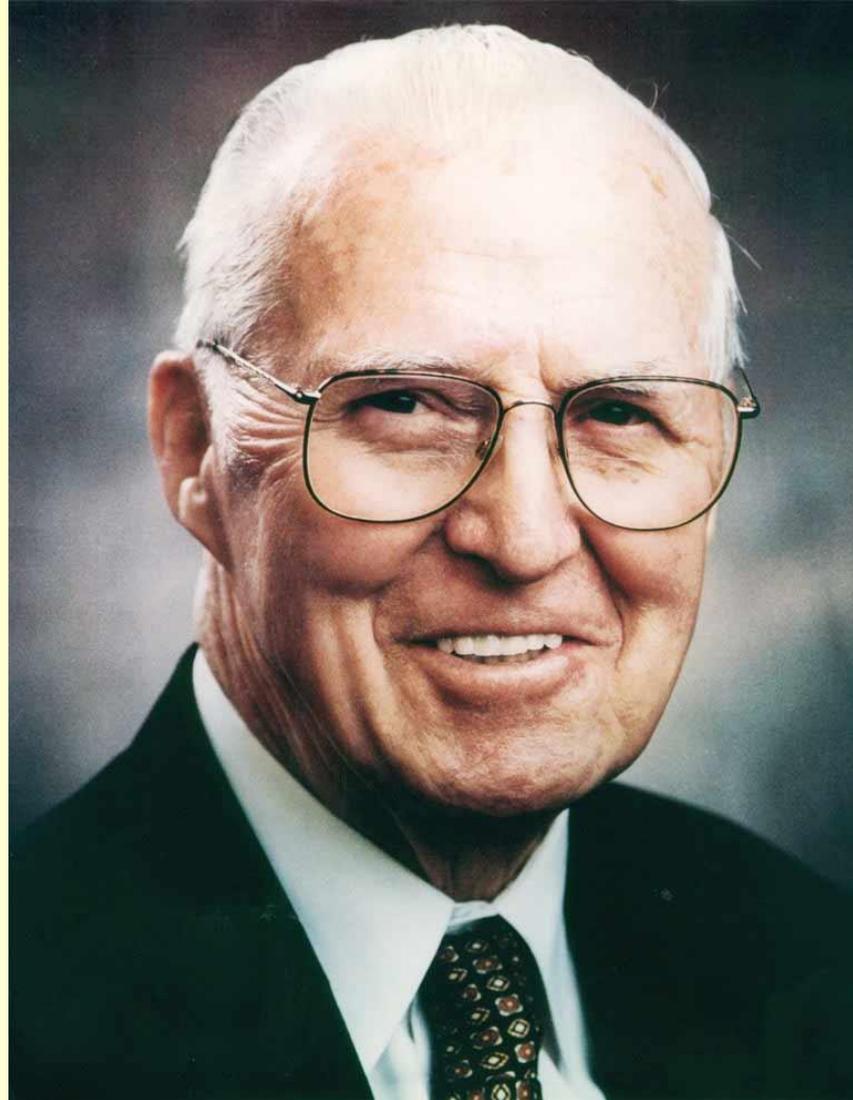


**Yes !**

**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...

Alkaloids

Terpenes

Plant's have an armory

Flavonoids

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, gugglesterone



*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*

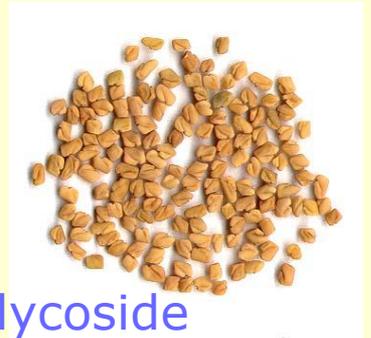


*Pterocarpus marsupium*, flavonoid



*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)



Betula alba

*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



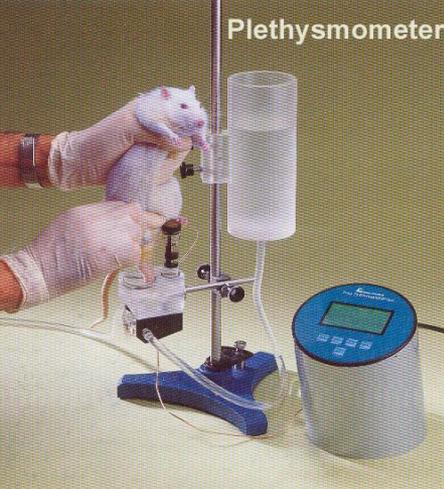
**Agriculture**



**A**



**Agrotechnology**



Plethysmometer



# 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

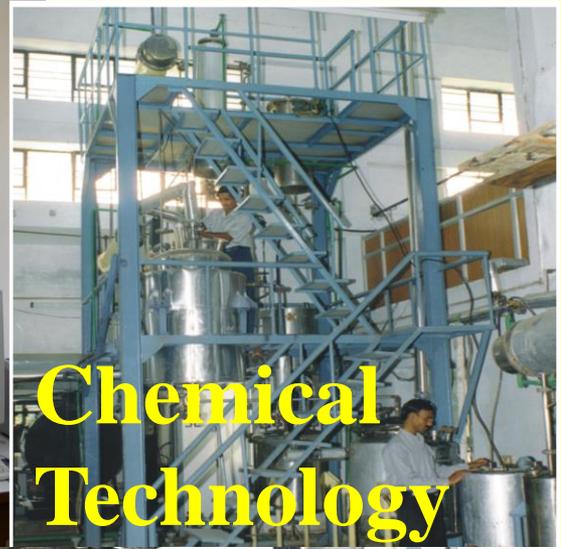


# Chemistry



# C

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



# Chemical Technology



# The Strategy

Reach the unreached  
...and link the unlinked



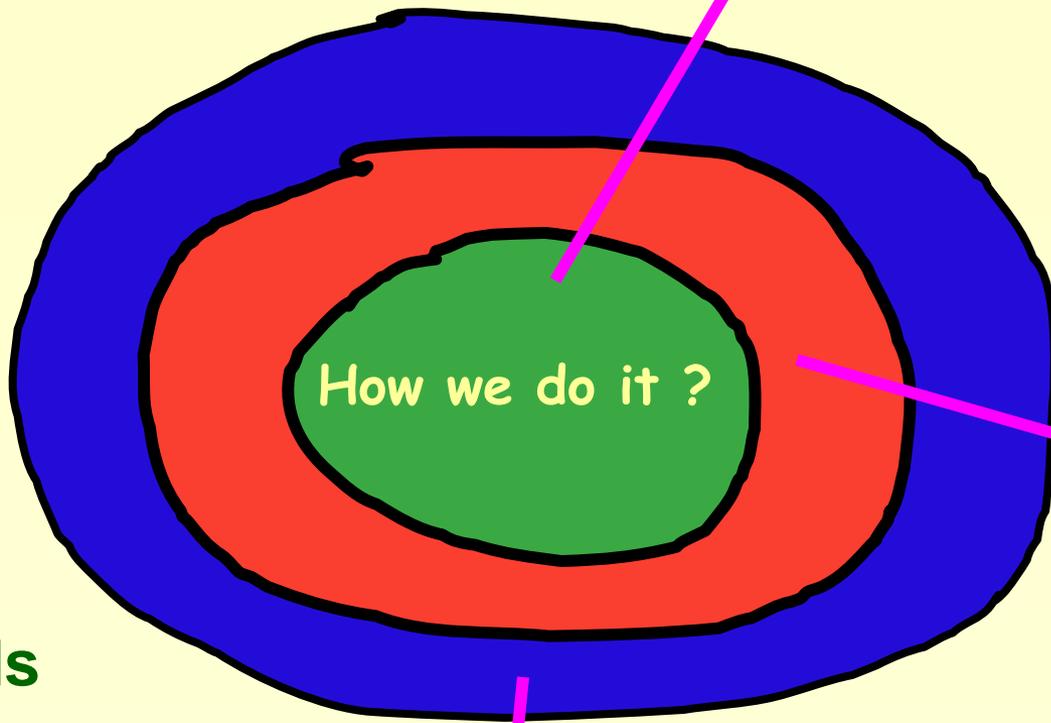
With upto 50,000 genes estimated in plants, more than 200,000 phytochemicals have been anticipated (Pichersky and Gang, 2000) with already around 50,000 compounds elucidated in plants (De Luca and St. Pierre, 2000)

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.



**Alkaloids**  
**Phenolics**  
**Terpenoids**



Processing Technologies

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.

**Products??**

# 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)

Active compound yield

Designer plants

Plant Biotechnology

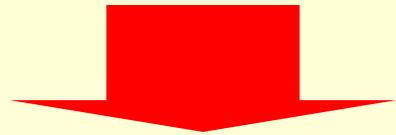
Marker assisted breeding

Metabolites *in vitro*

Quantification of diversity

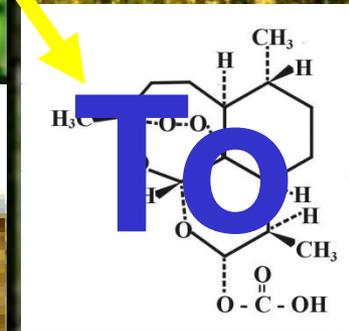
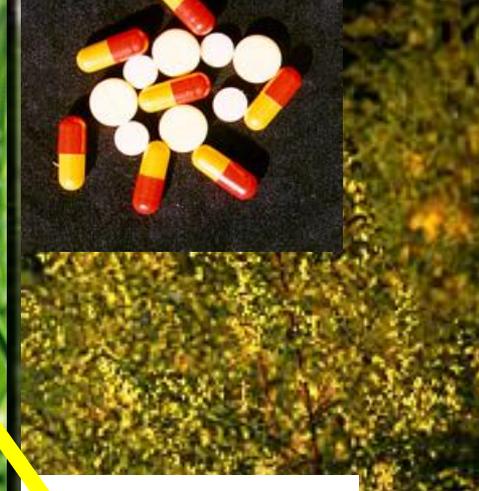
Genomics

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

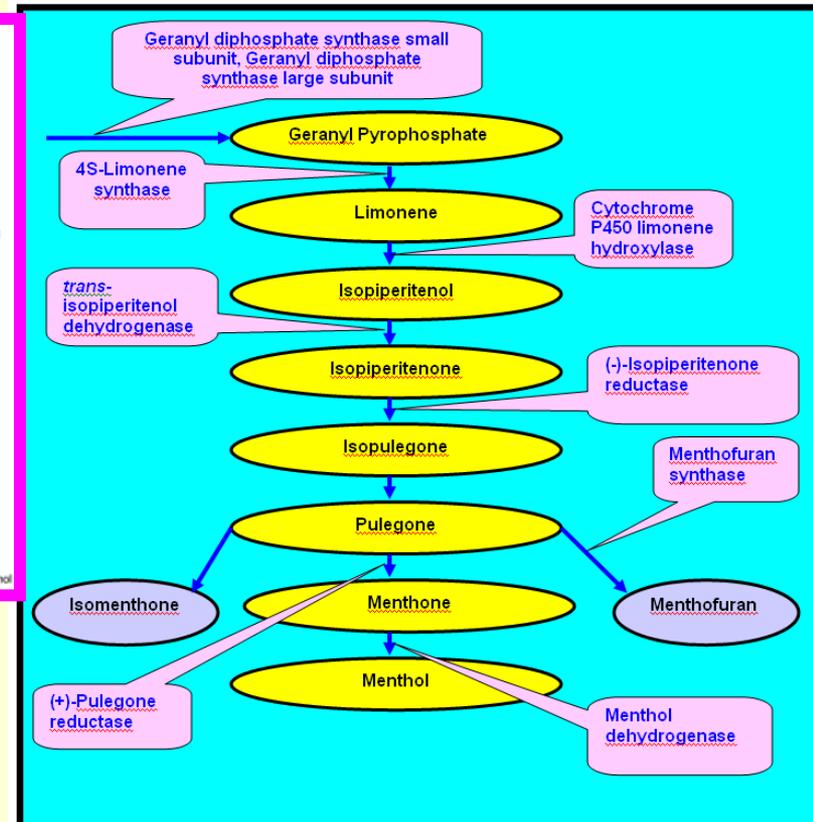
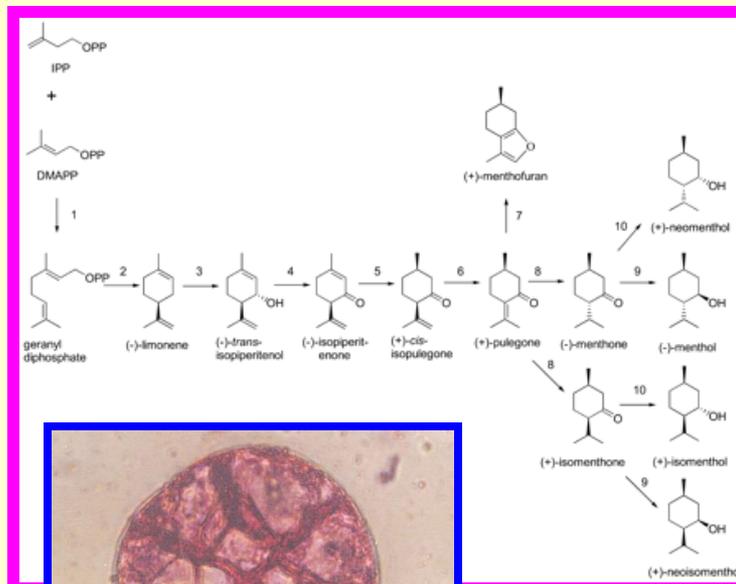
India exported 9546 tonnes of menthol 2005-2006 worth Rs 550.29 crores (Department of Commerce, Govt. of India).

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

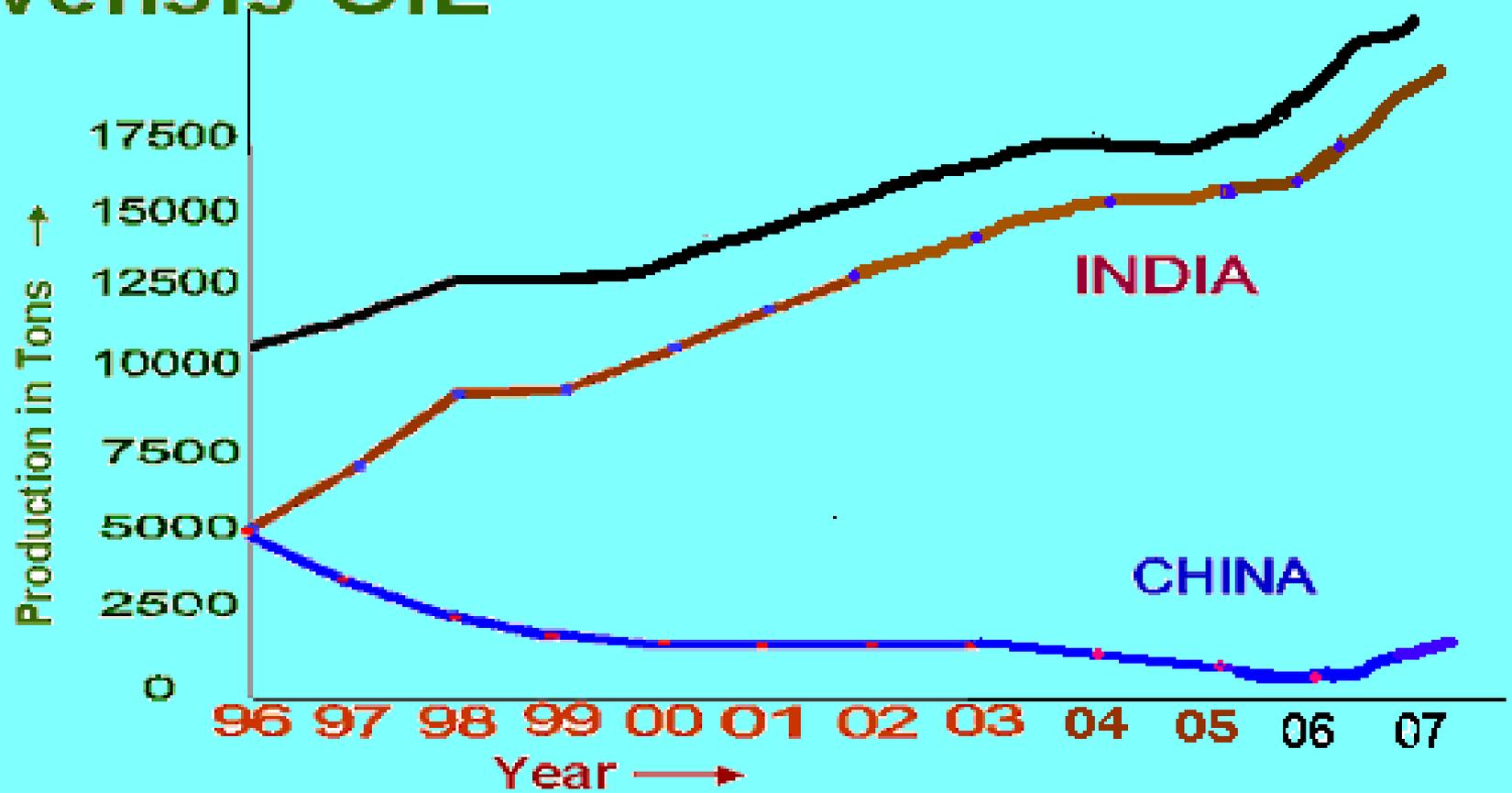
- The natural oil yields on an average 40-50% menthol and 50-60% dementholised oil, which can be used both in confectionery and medicine in place of imported peppermint oil.
- Japanese mint oil is not distinguished from the peppermint oil in the Indian trade.
- The dementholised oil has been found to 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

<b>Particular</b>			
<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)

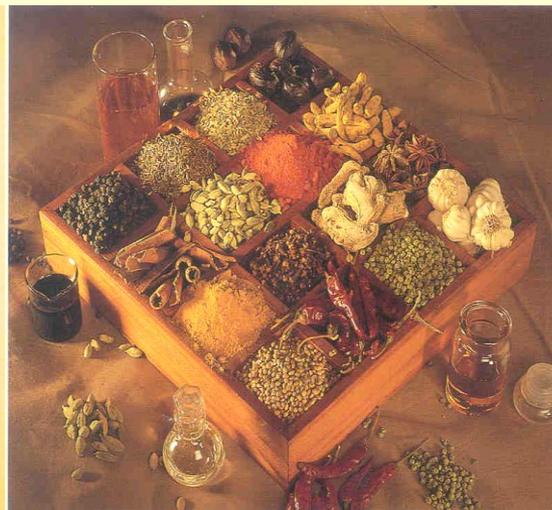
ITEM	2006 - 07(E)	
	QTY	VALUE
PEPPER	28,750	306.02
CARDAMOM(S)	650	22.36
CARDAMOM(L)	1,500	16.95
CHILLI	148,500	807.75
GINGER	7,500	39.75
TURMERIC	51,500	164.80
SEED SPICES	70,125	362.52
VANILLA	125	19.96
CURRY POWDER	9,500	86.93
MINT PRODUCTS	16,250	1100.95
OILS & OLEORESINS	6,250	510.79
<b>TOTAL (Including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



# India's Share In Value Added Spices

*Qty in Tons*

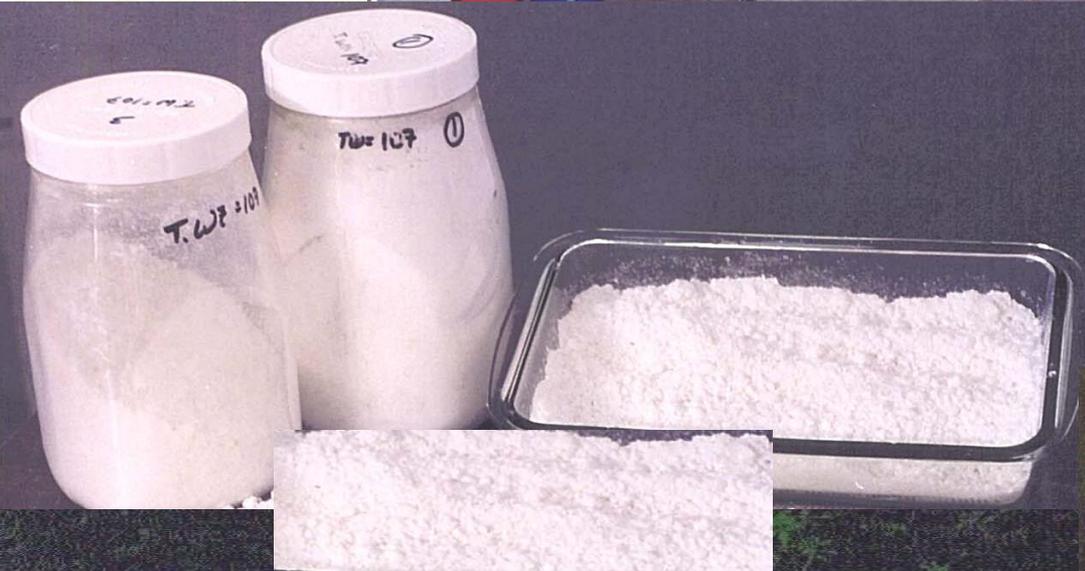
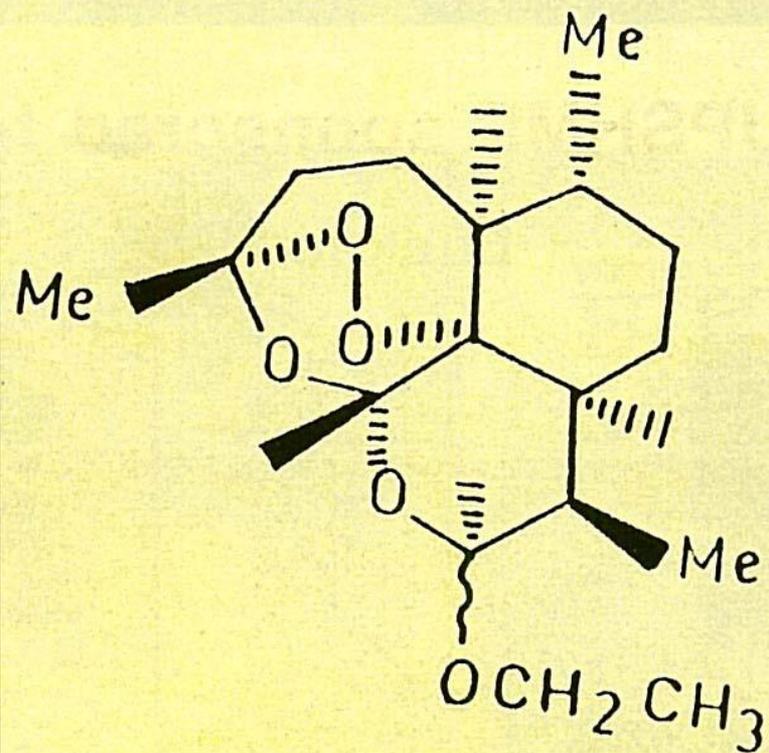
SPICES	INDIA'S EXPORT	WORLD TRADE	% SHARE
SPICE OILS & OLEORESINS	6250	7500	83
MINT PRODUCTS	16250	30000	54



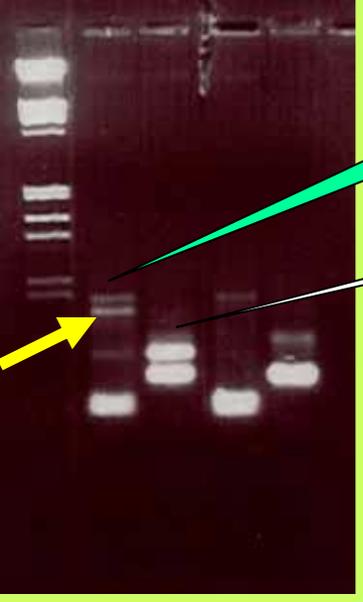
# Plant molecules for Health

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

It works



Artemisinin and arteether



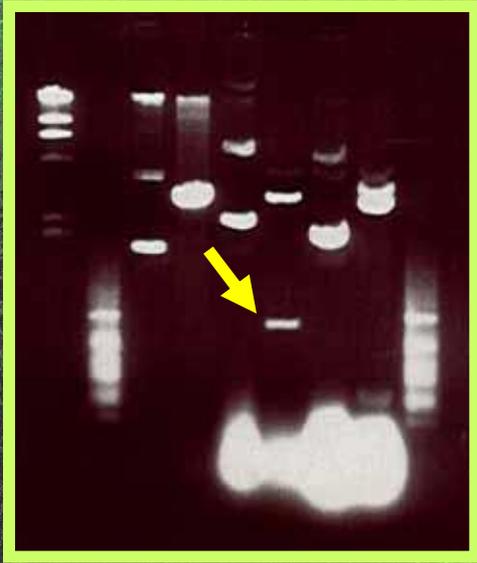
High type

Low type

Synthesis of primers

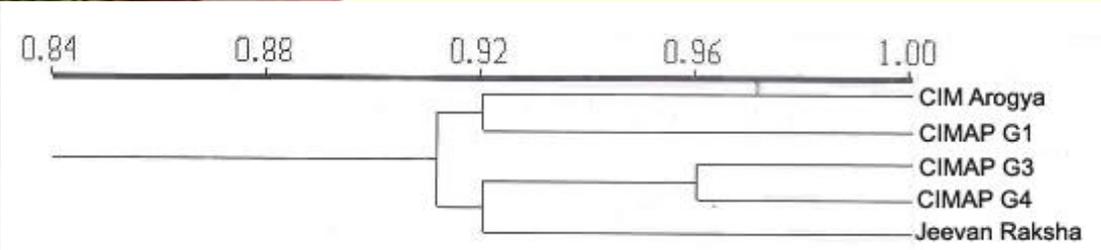
Sequence

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 31<sup>st</sup> RC Meeting



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



M/s Biotech International Limited, New Delhi signed agreement with CIMAP on 5<sup>th</sup> 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 17<sup>th</sup> November, 2005 for CIM-Arogya technology demonstration in Chandigarh



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



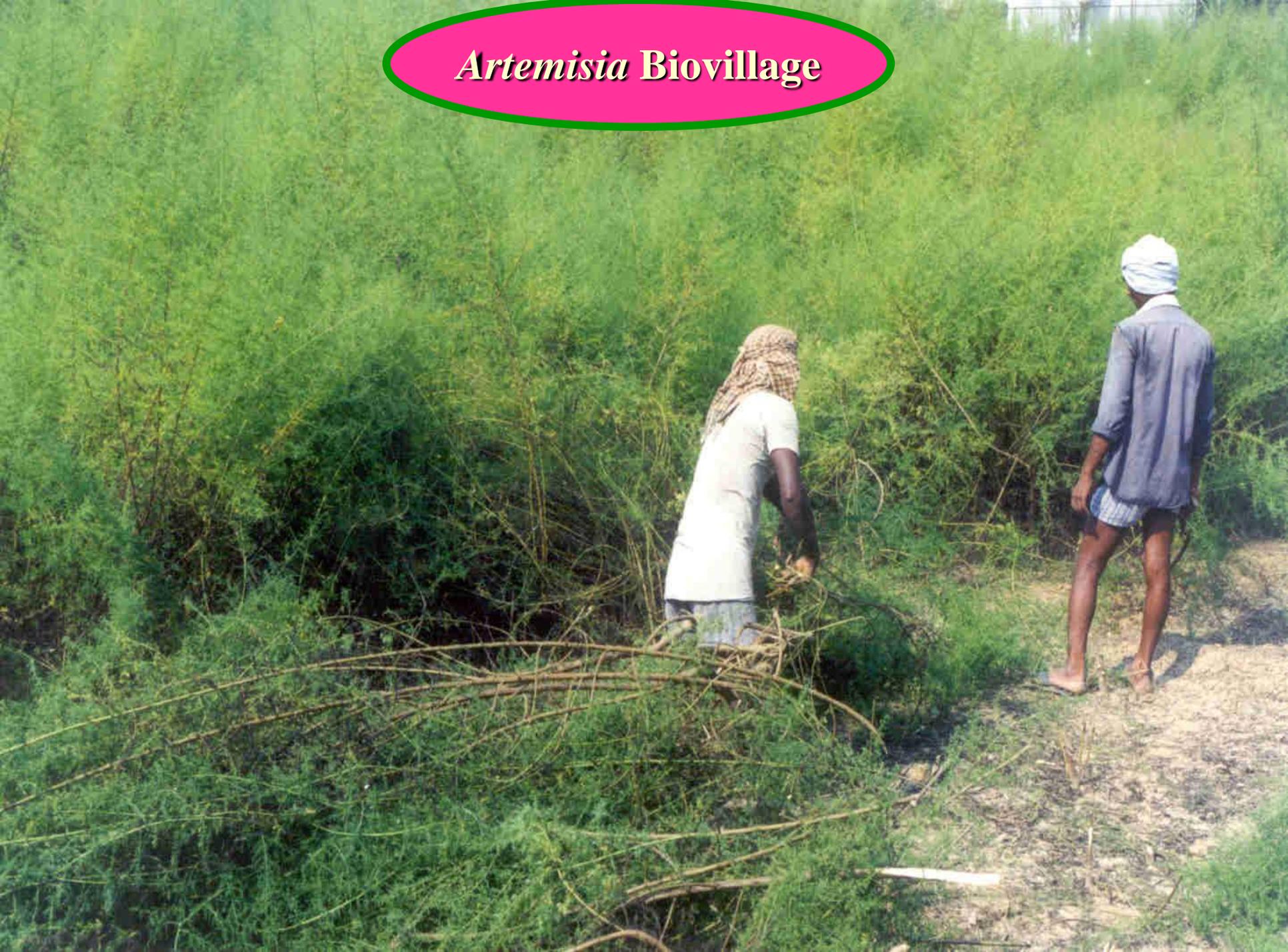
Signing of agreement with GSFC, Vadodara on CIMAP Annual Day on 26<sup>th</sup> March, 2006 for licensing industrial technologies of *Artemisia*, *Silybum* and *Geranium*



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



# *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 artemisinin, 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. ...)

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



# आर्टीमिसिया जैव ग्राम मिशन का शुभारम्भ

## LAUNCHING OF ARTEMISIA BIOVILLAGE MISSION

18 फरवरी, 2005



## Source of New Hope Against Malaria is in Short Supply

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

It seemed like a classic case of bait and switch. In 2004, the World Health Organization (WHO) and the Global Fund for AIDS, Tuberculosis, and Malaria threw their weight behind a radical change in the fight against malaria in Africa. Old, ineffective drugs were to be abandoned in favor of new formulations based on a compound called artemisinin that could finally reduce the staggering death toll. More than 20 African countries have signed on. But the catch is there aren't nearly enough of the new drugs to go around.

Just before Christmas, WHO—which buys the tablets from Novartis for use in African countries—announced that it would deliver only half of the 60 million doses anticipated in 2005, leaving many countries in the cold. “It’s a very cruel irony,” concedes Allan Schapira of WHO’s Roll Back Malaria effort.

Other companies producing the drugs have the same problem as Novartis. Artemisinin is derived from plants grown primarily on Chinese and Vietnamese farms, and they have not kept up with demand. Several plans are afoot to create a new, more stable, and cheaper source. Last month, for instance, the Bill and Melinda Gates Foundation announced a \$40 million investment in a strategy to make bacteria churn out a precursor to artemisinin. But such alternatives will take at least 5 years to develop, so the shortages are likely to persist, warns Jean-Marie Kindermans of Médecins sans Frontières in Brussels.

New malaria drugs are badly needed. The parasite *Plasmodium falciparum* has developed resistance to the mainstays, such as chloroquine and sulfadoxine-pyrimethamine. The death toll—more than a million annually—is not declining, despite Roll Back Malaria, an ambitious international campaign launched in 1998 to halve mortality by 2010.

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

artemisinin compounds always be used with a second drug in a so-called Artemisinin-based Combination Therapy, or ACT.

Widely used in Asia, the introduction of ACTs in Africa has lagged. Countries have been reluctant to make the switch because, at



**Fields of gold.** Extracts of *Artemisia annua* (bottom) provide powerful new malaria drugs, but farms have not met demand for the shrub.

about \$2.40 per treatment course, ACTs are 10-20 times more expensive than existing drugs. The Global Fund has also dragged its feet, some allege, by funding the purchase of older, cheaper drugs for too long. Things began to change when an expert group published a scathing letter in *The Lancet* in January 2004, accusing the Global Fund and WHO of “medical malpractice.” Both organizations denied the claims, explaining that they supported ACTs but that change took time. Both also concede that the ensuing debate spurred them to redouble their efforts.

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

nearly enough money to fund the drugs’ introduction across Africa. Donor countries like the U.S. and the U.K. appear reluctant to spend aid money on market guarantees for big pharma, says Schapira, because it could be seen as lining shareholders’ pockets; at an emergency session at WHO just before Christmas, no donors made any commitments.

WHO’s hope is that growing demand will eventually create a stable artemisinin supply at low prices. *Artemisia* farms are now springing up in India, and WHO is supporting experiments to grow the plants in east Africa.

The Gates Foundation is banking on a less fickle supply route. Over the past 10 years, chemical engineer Jay Keasling and colleagues at the University of California, Berkeley, have spliced nine genes into *Escherichia coli* bacteria to make them produce terpenoids, a class of molecules that includes artemisinin. With a few genes borrowed from *Artemisia*, they should be able to produce an artemisinin precursor, Keasling says.

On 13 December, the foundation announced a \$42.6 million grant to the Institute for OneWorld Health in San Francisco—which bills itself as the world’s first non-profit pharmaceutical company—to help Keasling finish the engineering. Then a biotech startup will optimize the process for producing artemisinin—“tons and tons of it,” says OneWorld Health president Victoria Hale—about 5 years from now. Her assumption is that pharmaceutical companies will package OneWorld’s artemisinin derivatives into ACT tablets and sell them at well under a dollar per treatment.

There’s another alternative. Jonathan Vennerstrom and colleagues at the University of Nebraska, Omaha have synthesized a compound called OZ277 (or simply OZ) that, like artemisinin, has a peroxide bridge shielded by large chemical rings. The compound has been tested as an antimalarial in vitro and in animals, and it looks even better than the real thing, Vennerstrom and colleagues reported in *Nature* in August. Ranbaxy, an Indian pharmaceutical company, is developing it further; a phase 1 safety trial has just been completed.

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.

—MARTIN ENSERINK

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**

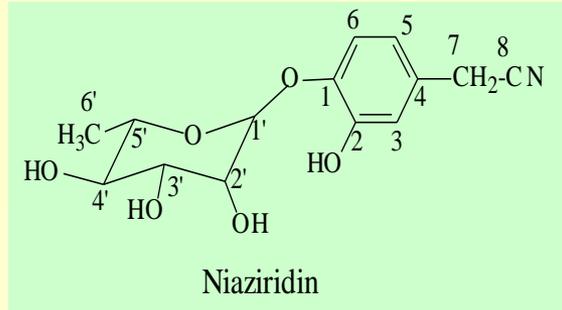


**It works**



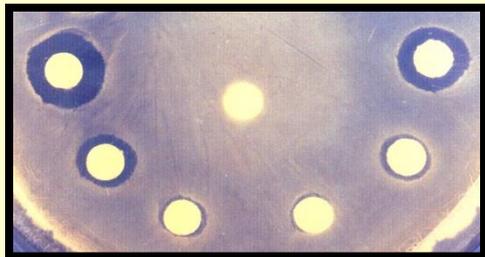
# Bioenhancers

Bioenhancer molecules identified (2000-01)



**Niaziridin**

2001-02



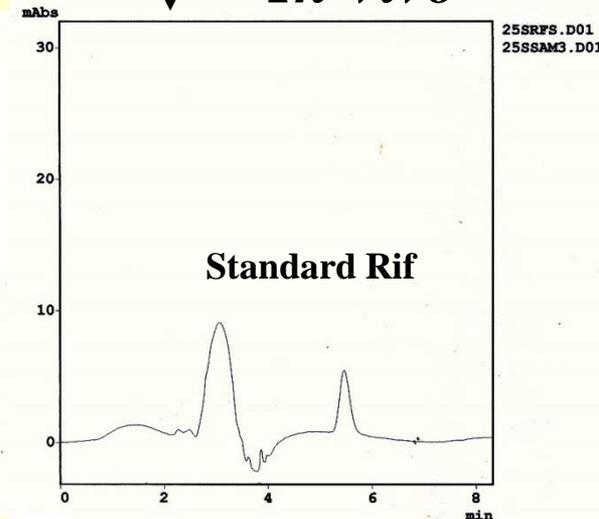
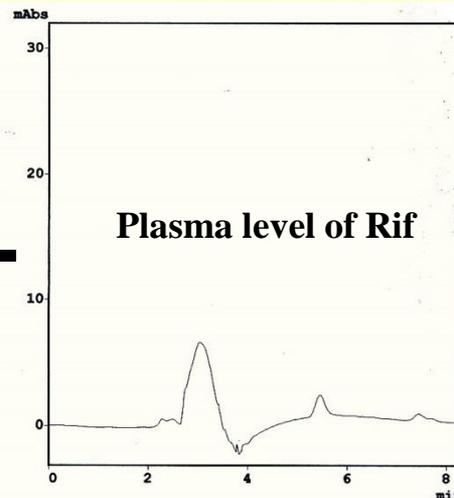
*In-vitro*

*In-vivo*

**Ready for commercial exploitation**

Toxicity (acute)

2005-06

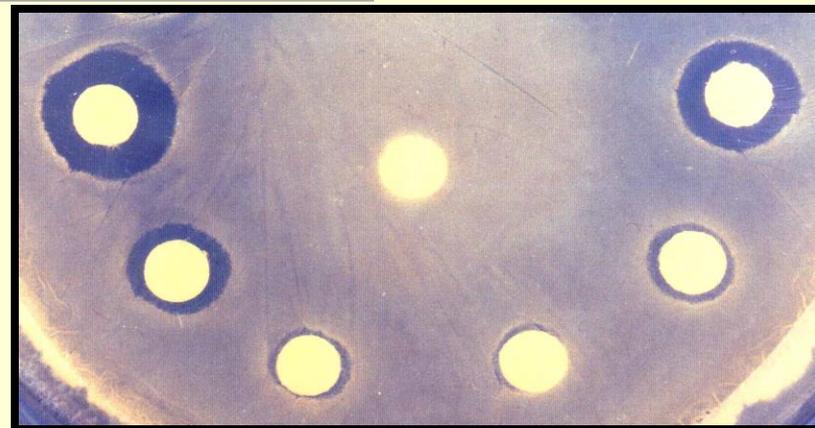
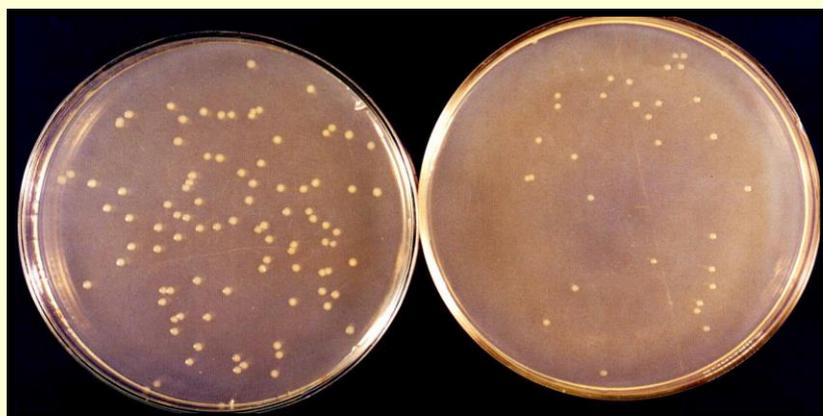


plasma level of rifampicin in rat model using HPLC method

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

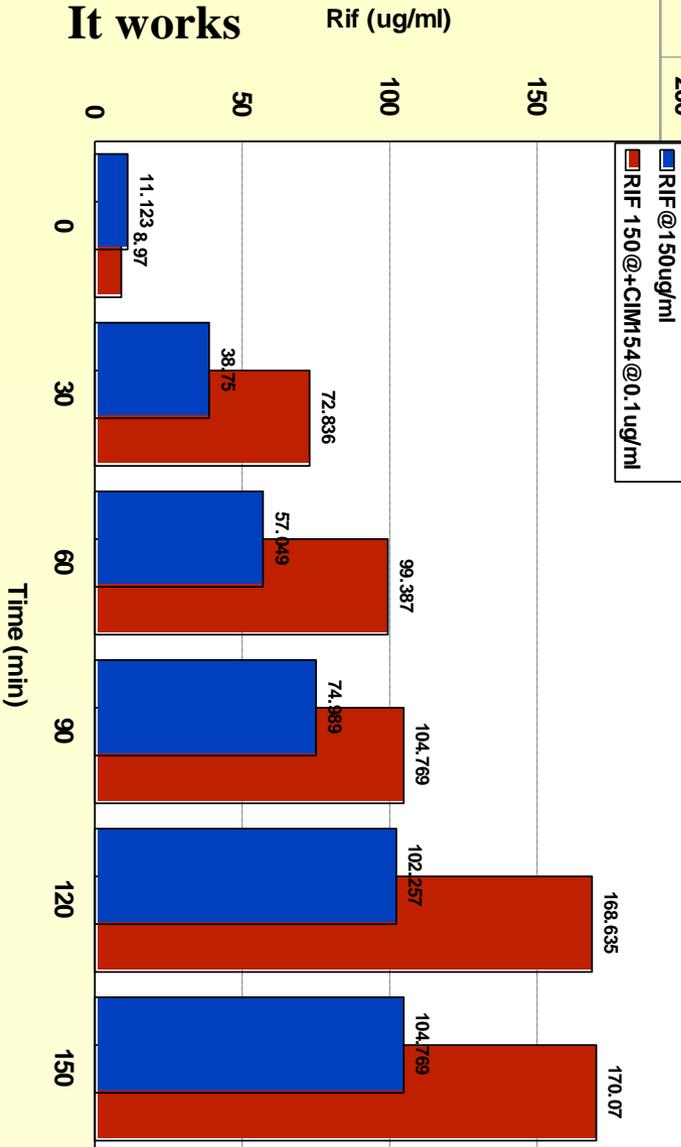
Antibiotics (µg/ml)	Titre	% Survival	Fold enhancement in killing over antibiotic alone.
<b>Control (LB)</b>	<b>1.1X10<sup>8</sup></b>	<b>100</b>	
<b>Rif (20)</b>	<b>1.5X10<sup>4</sup></b>	<b>0.0136</b>	<b>--</b>
<b>Rif (20)+CIM 154</b>	<b>3.9X10<sup>3</sup></b>	<b>0.0035</b>	<b>38.8</b>
<b>Rif (30)</b>	<b>3.8X10<sup>4</sup></b>	<b>0.038</b>	<b>--</b>
<b>Rif (30)+CIM 154</b>	<b>3.0X10<sup>3</sup></b>	<b>0.003</b>	<b>12.6</b>
<b>Control (LB)</b>	<b>6.0X10<sup>8</sup></b>	<b>100</b>	
<b>Nal (6)</b>	<b>6.0X10<sup>6</sup></b>	<b>1.0</b>	<b>--</b>
<b>Nal (6) + CIM 154</b>	<b>1.2X10<sup>5</sup></b>	<b>0.02</b>	<b>50.0</b>

**It works**



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

It works

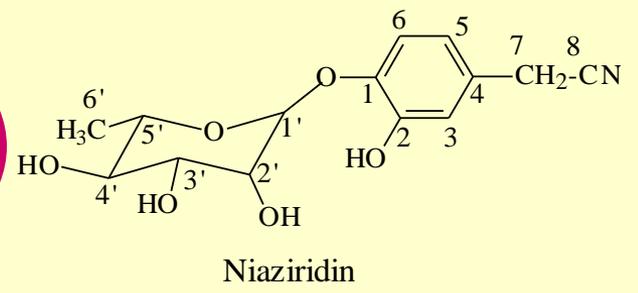


Time Interval (Minutes)	Rif @ 150 µg/ml	Rif +CIM 154 @ 0.1 µg/ml	Percent Enhancement
0	11.123 µg/ml	8.970 µg/ml	-
30	38.75 µg/ml	72.836 µg/ml	87.96
60	57.049 µg/ml	99.387 µg/ml	74.21
90	74.989 µg/ml	104.769 µg/ml	39.71
120	102.257 µg/ml	168.635 µg/ml	64.91
150	104.769 µg/ml	170.07 µg/ml	62.32

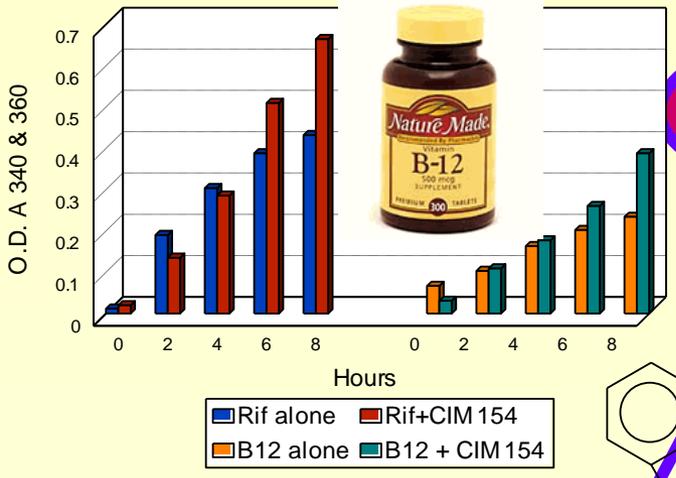


**Antiinfective market (\$20B)**  
**Antibacterials 65%~\$13B**  
**10% of the market 130 million**  
**5 to 10 folds activity enhancement**  
**Net savings:104 to 117 million \$**

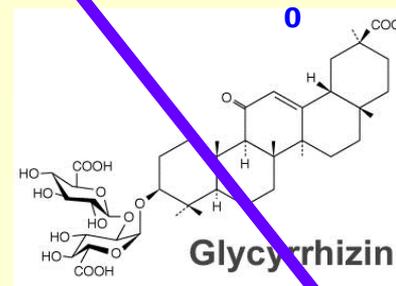
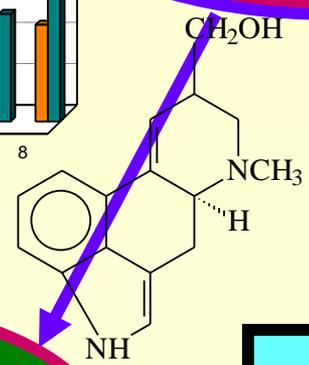
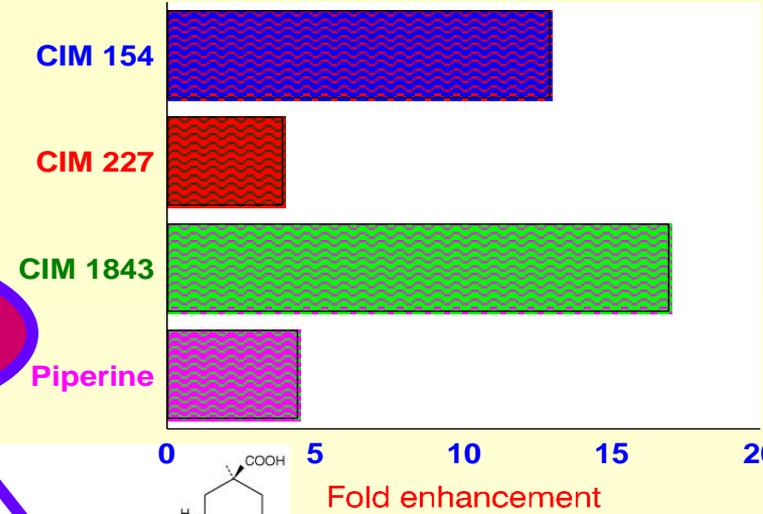
**CIM 154**  
**Niazidirin**  
*(Moringa oleifera)*



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



**Bioenhancers**



**CIM 227 (Lysergol)**  
*Ipomoea muricata*

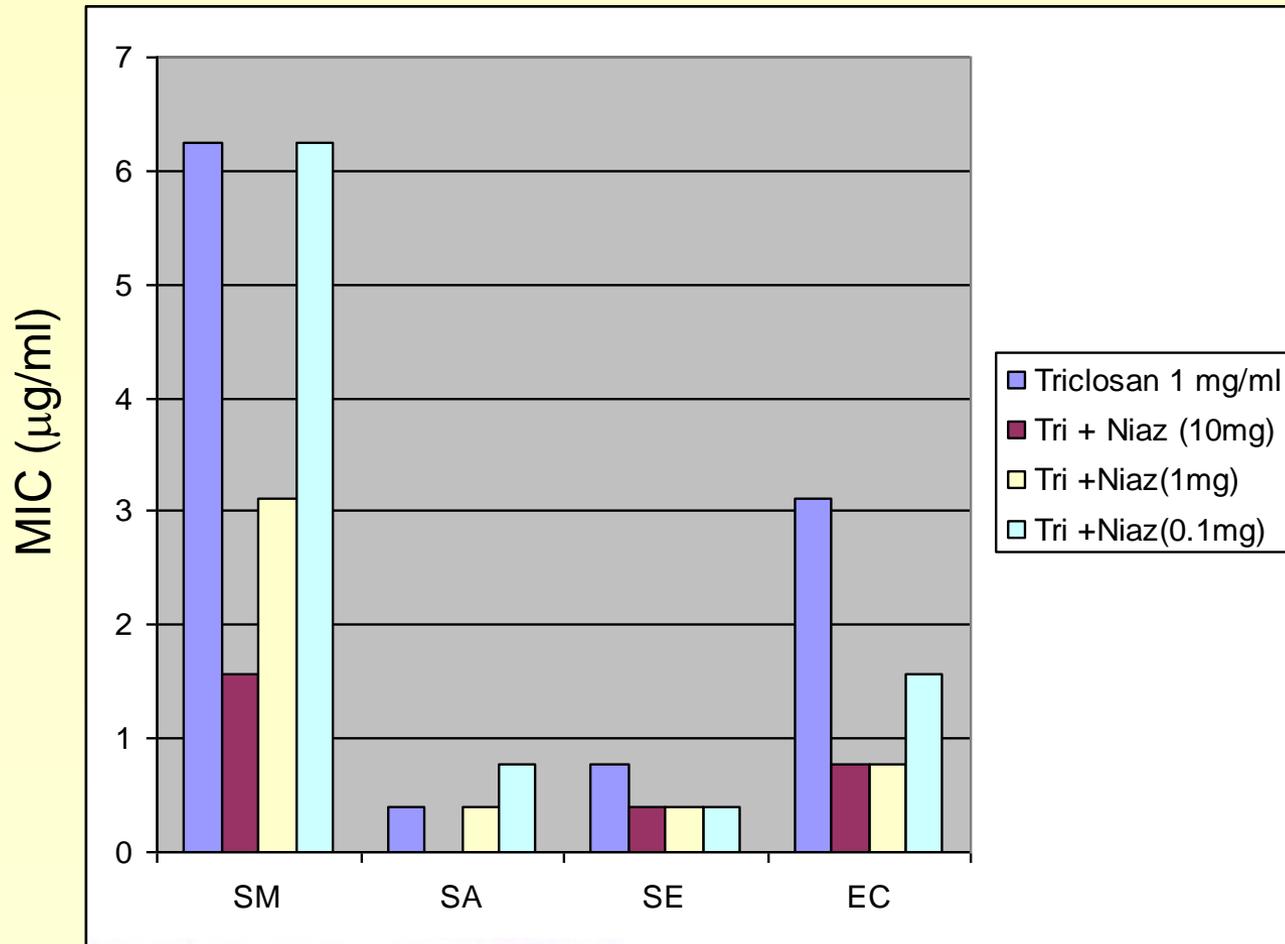
- Niaziridin
- Lysergol
- Glycyrrhizin
- Lichesterinic acid
- CIM 1865 & CIM 1998
- Rose water components

**CIM 1843(Glycyrrhizin)**  
*Glycyrrhiza glabra*

**It works**

# Reduction in MIC of Triclosan in presence of niaziridin

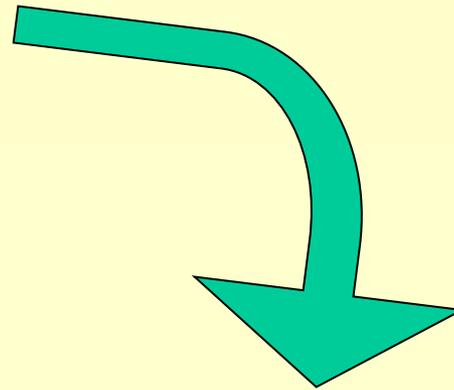
It works



It works

# Genetic screen based bioprospecting for antibacterials

(2000-01)



## Drug resistance prevention system

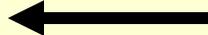
**IDMA Patent Appreciation Award for US Patent No.6,423,741**

on

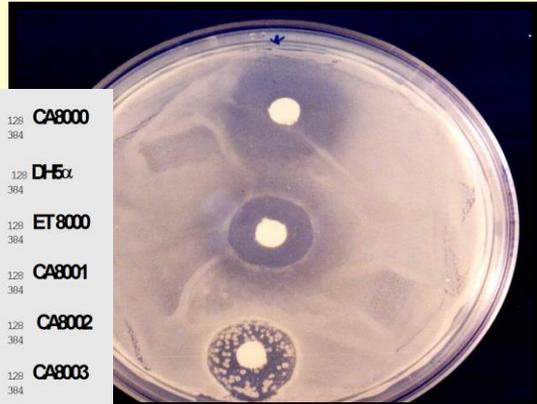
**“Antimicrobial composition and the method for producing the same”**

**from Indian Drug Manufacturers Association, Mumbai**

**2005**



113 His Pro His Gly Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8000 384
113 His Pro His Gly Asp Ser Ala Val Tyr Asn Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT AAC ACG ACC GTC CXC AATG GGG	128 DH5α 384
113 His Pro His Gly Asp Ser Ala Val Tyr Asn Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT AAC ACG ACC GTC CXC AATG GGG	128 ET8000 384
113 His Pro His Gly Asp Ser Ala Val Tyr Tyr Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT TAC ACG ACC GTC CXC AATG GGG	128 CA8001 384
113 His Pro His Gln Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 337 CPT CXC CPT GAT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8002 384
113 His Pro His Gly Asp Ser Ala Val Tyr Gly Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8003 384
113 His Pro His Gly Asp Leu Ala Val Tyr Asn Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT AAC TGG GGG GTC TTT AAC ACG ACC GTC CXC AATG GGG	128 CA8004 384
113 His Pro His Gly Asp Ser Ala Val Tyr Gly Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8005 384
113 His Pro His Gly Asn Leu Ala Val Tyr Asn Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT AAC TGG GGG GTC TTT AAC ACG ACC GTC CXC AATG GGG	128 CA8006 384
113 His Pro His Asp Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8007 384
113 His Pro His Gly Asp Leu Ala Val Tyr Asp Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8008 384
113 His Pro His Gly Asp Ser Ala Val Tyr Asp Thr Ile Val Arg Met Ala 337 CPT CXC CPT GGT GAC TGG GGG GTC TTT GAC ACG ACC GTC CXC AATG GGG	128 CA8009 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

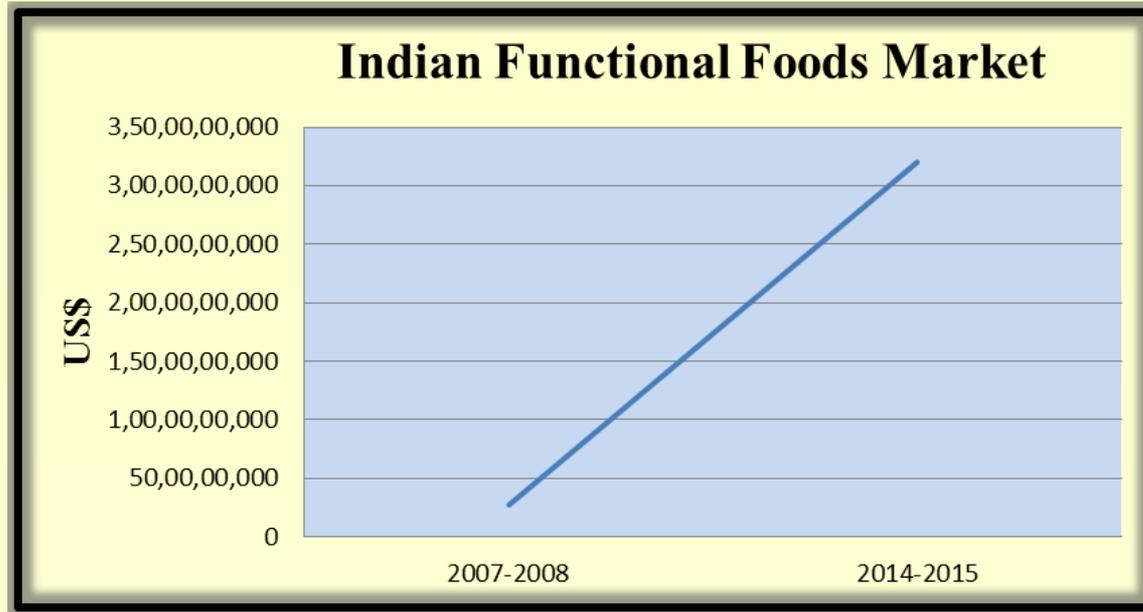
- Carotenoids (like  $\beta$ -carotene, lutein, zeaxanthin, lycopene)
- Fiber (insoluble fiber,  $\beta$ -glucan, soluble fibres, whole grains)
- Fatty acids (mono-unsaturated fatty acids, poly-unsaturated fatty acids like omega-3-fatty acids, ALA, DHA, and conjugated linoleic acid)
- Flavonoids (anthocyanidins, 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



22000 described  
*Mentha species, Cymbopogon Species, Ocimum Species, Pelargonium species, Clarkia breweri, Petunia etc*

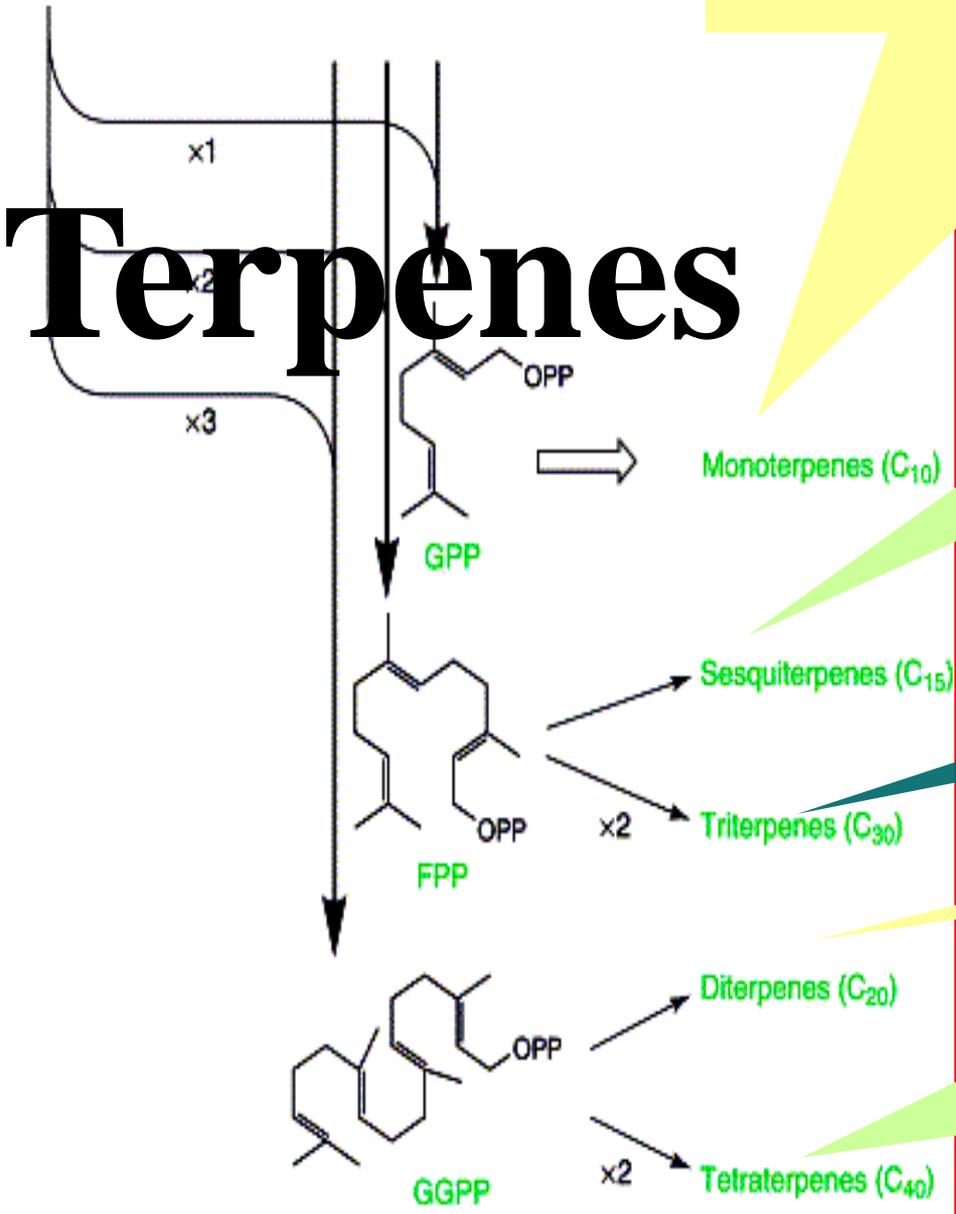
Sesquiterpene lactones (SL's) of which over 3000 have been described, mostly in the Asteraceae (daisy) family  
*Artemisia annua, Pyrethrum, Chicory, Tulip, Tagetus, Sage, cotton, Tansy, Yarrow, Chamomile, Arnica etc*

*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*

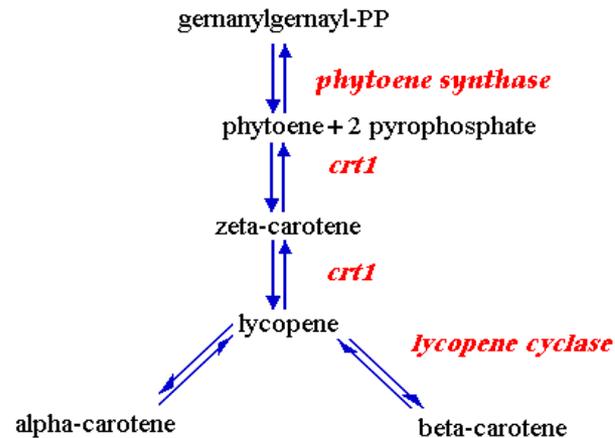
*Stevia rebaudiana, Tinospora cordifolia, Panax notogingsang etc*

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

# Terpenes

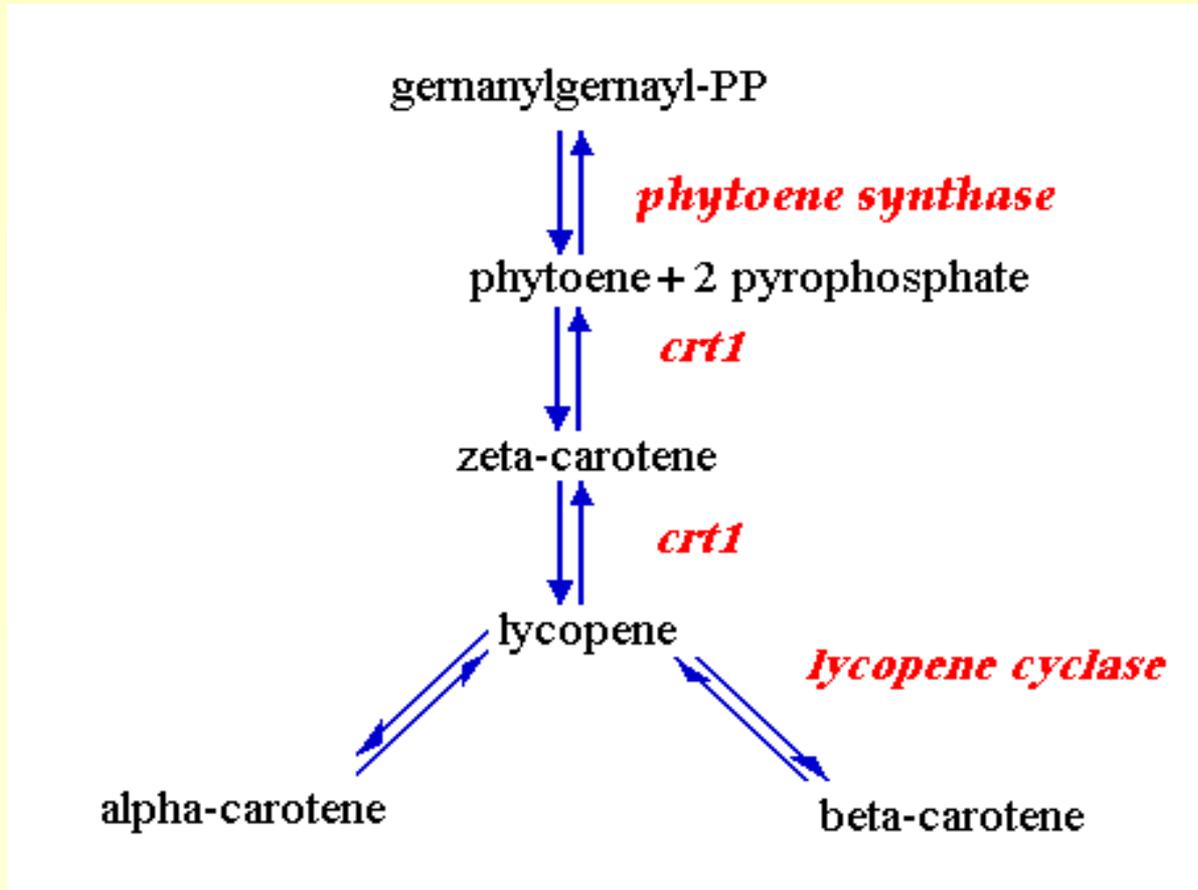


## Ingro Potrykus and Peter Beyer



*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



## Nutritional Potential / Use:

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

Salvia  
hispanica  
2mm long



## 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



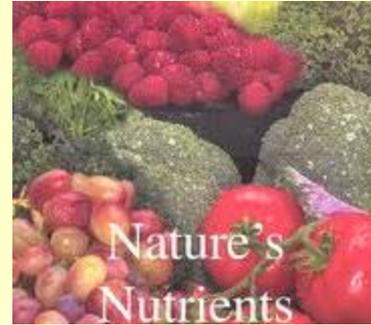
## R & D Challenge / Scope:

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

# $\beta$ -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 granatum*



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**, **gallo catechins**, 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-ida*)  
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



113676 Nucleotides

362193 ESTs

76179 Proteins

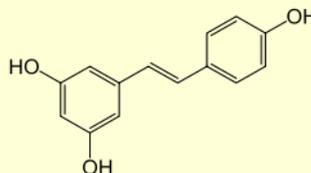
A grape is a **non-climacteric** fruit. It can be eaten raw or used for making jam, juice, jelly, vinegar, wine, grape seed extracts, raisins, and grape seed oil. It is also used in some kinds of confectionery.

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

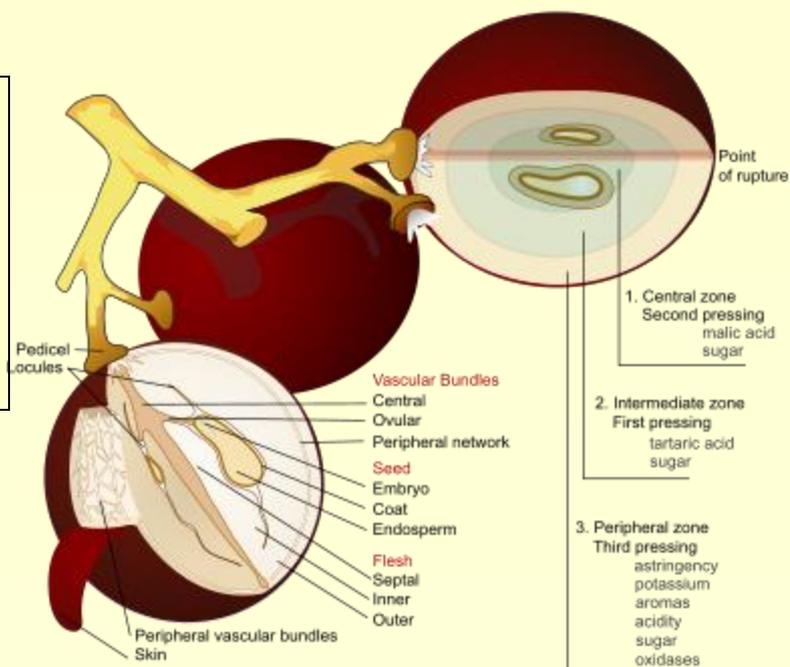
## French Paradox

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](http://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.*

3<sup>rd</sup> 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*

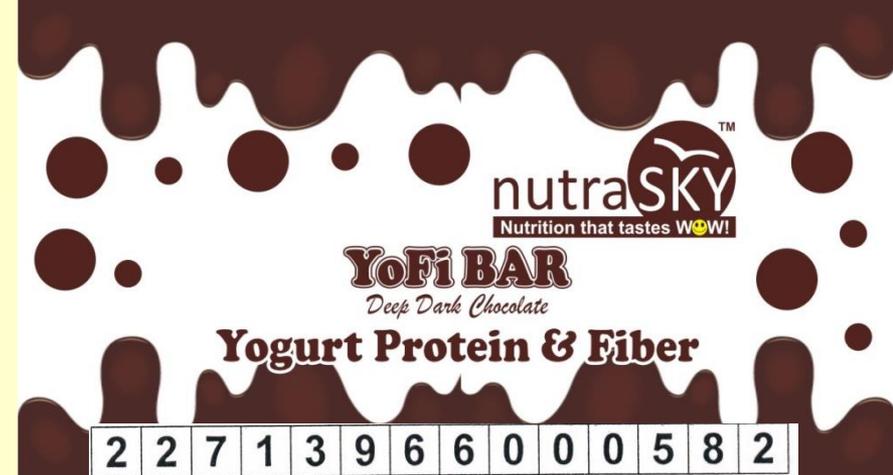
Research & Development : SKiES Lab, Biotech Park, Kursi Road, Lucknow 226021, UP, INDIA  
Head Office : SKiES, E-6, Office-1, 1st Floor, Bali Nagar, New Delhi 110015, INDIA

Contact: Biotech Park : +91 8765346971,

Head Office : +91 11 25937717

info@skiesindia.com

www.skiesindia.com



FSSAI Registration

2<sup>nd</sup> July 2013

**YOGURT  
PROTEIN  
FIBER**

**YOFI BAR**  
*Classic Milk Chocolate*





# 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

Research Centre: Biotech Park, Kursi Road, Lucknow 226021, UP, INDIA  
 Production Centre: G 4 & 5, UPSIDC-1A, Agro Park II, Barabanki 225302, UP, INDIA  
 Innovation Centre: E-6, Office-1, 1st Floor, Bali Nagar, New Delhi 110015, INDIA

Contact: Biotech Park : +91 8765346971, Head Office : +91 11 25937717  
 info@skiesindia.com www.skiesindia.com



## Suman Khanuja Innovation Enterprises

Research Centre: Biotech Park, Kursi Road, Lucknow 226021, UP, INDIA  
 Production Centre: G 4 & 5, UPSIDC-1A, Agro Park II, Barabanki 225302, UP, INDIA  
 Innovation Centre: E-6, Office-1, 1st Floor, Bali Nagar, New Delhi 110015, INDIA

Contact: Biotech Park : +91 8765346971, Head Office : +91 11 25937717  
 info@skiesindia.com www.skiesindia.com

# Acknowledgement...



**Team CIMAP (CSIR)**

**The green path to better health & life**

# Acknowledgement...



13/08/2011





[www.skiesindia.com](http://www.skiesindia.com)

**Best of Learning !**

**SUMAN KHANUJA INNOVATION ENTERPRISES**

**SKiES Life Technologies Pvt. Ltd.**

*Bringing nature to life*

**Suman P S Khanuja**  
**Founder, SKiES India**  
**Director & Mentor SKiES Life Technologies**

[khanujazy@yahoo.com](mailto:khanujazy@yahoo.com)  
[spskhanuja@gmail.com](mailto:spskhanuja@gmail.com)  
[spskhanuja@skiesindia.com](mailto:spskhanuja@skiesindia.com)