



## Revisiting horticulture as health sector catalyst through fruit genomes and metabolites expression

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**Session on “Ayurceuticals”**

*The Marriage of Traditional Knowledge and Modern Science*

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## Vision

Enabling quality of life through health sense in foods by science driven products in nutrition aids, functional foods and nutraceuticals.

## Our Mission

- ✓ Providing an enabling industrial platform for translation of research discoveries in food and nutrition science to develop health aid products and active ingredients
- ✓ Empowering the business of next generation nutraceuticals and value added functional foods and products for preventive healthcare of living beings
- ✓ To enable “right to live healthy” a reality through cost effective novel functional foods and nutraceuticals towards societal nutritional security
- ✓ Ensuring the quality, safety, efficacy and scientific validation of products of various food matrices and ingredients reaching the consumers



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

**Terpenes**

**Alkaloids**

**Plant's whisper**

...the phytochemicals

**Flavonoids**

**Glycosides**

**Saponins**

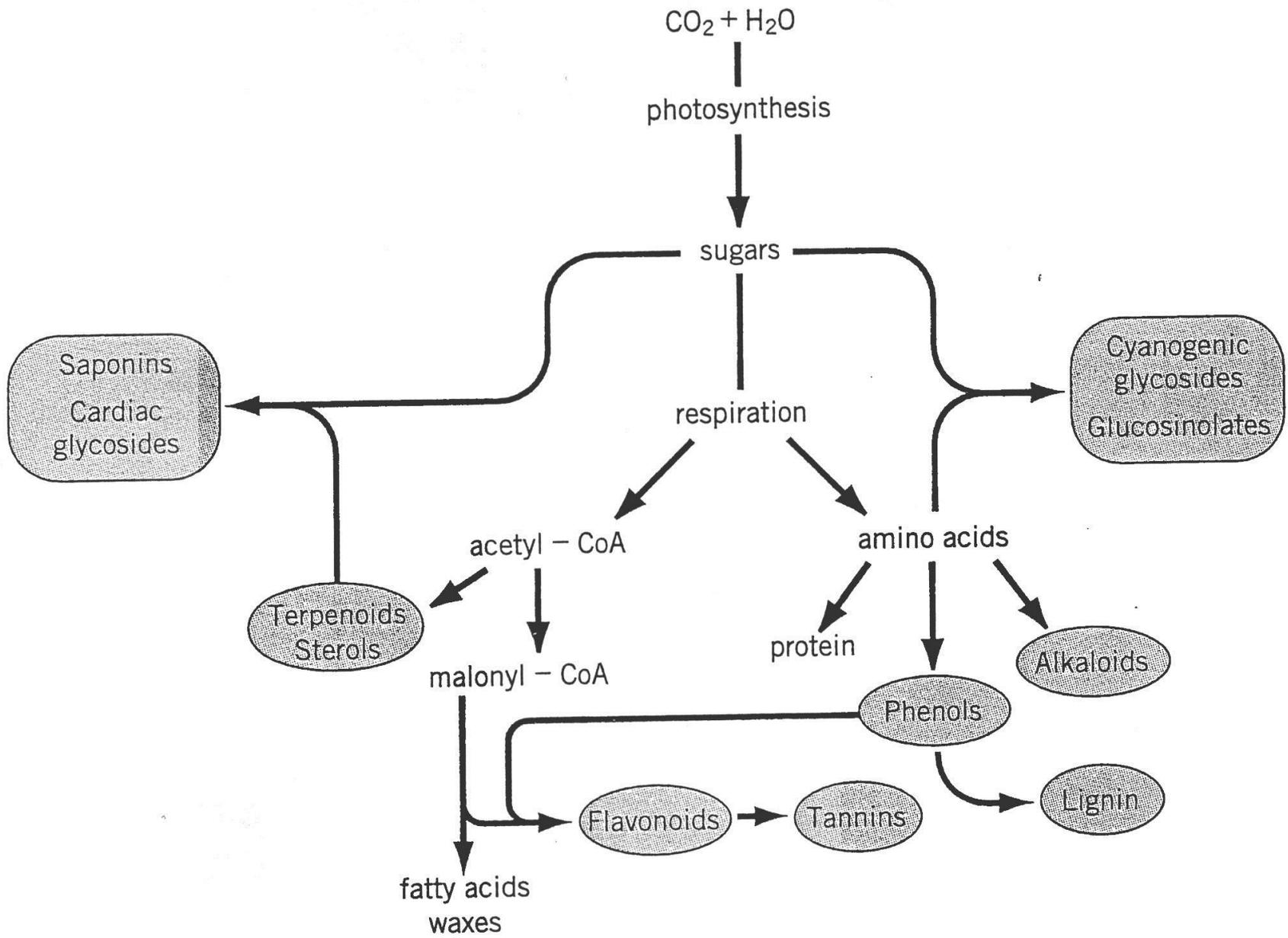
# Phytochemicals ...

It is estimated that terpenes contributes the most to the sales of plant-derived drugs. As the taxoids gain as treatment for cancer, the terpene category should increase its share still further in the next several years. Steroids are another key group in the terpene category.

Glycosides are the next most significant category. Flavonoids, saponins, anthraglycosides and digitalis compounds are among the most important groups within this category.

Alkaloids are the third most significant category of plant-derived drugs, in terms of sales. Included are the belladonnas, camptothecins, opiates, Rauwolfias, and Vincas, among others.

All other plant-derived drugs include miscellaneous substances and plant drugs for which the active principles have not been well characterized. Among the important groups within this category are plant-derived vitamins, psoralens, ephedrines, salicylates and various others.





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

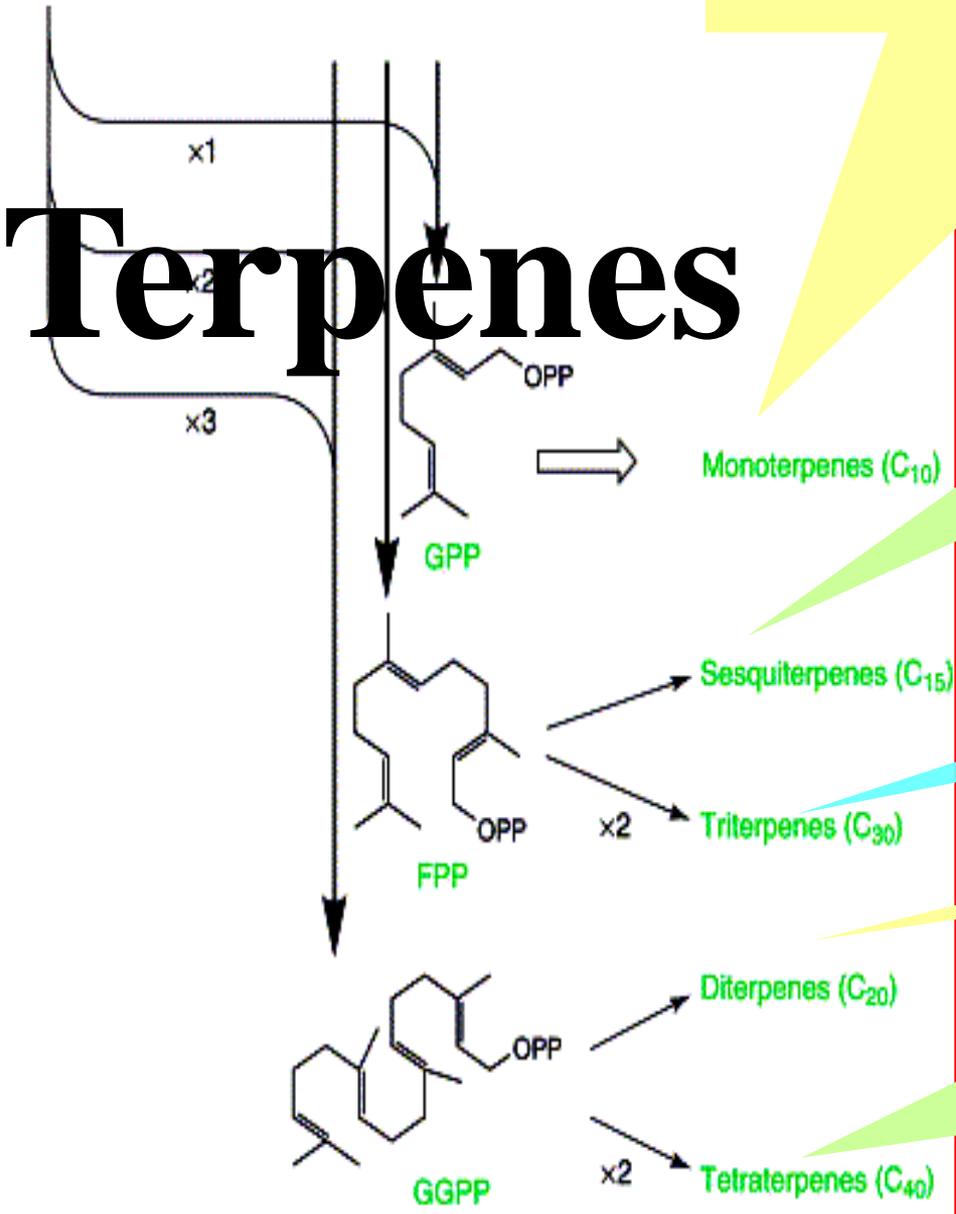
Sesquiterpene lactones (SL's) of which over 3000 have been described, mostly in the Asteraceae (daisy) family  
*Artemisia annua, Pyrethrum, Chicory, Tulip, Tagetus, Sage, cotton, Tansy, Yarrow, Chamomile, Arnica etc*

*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*

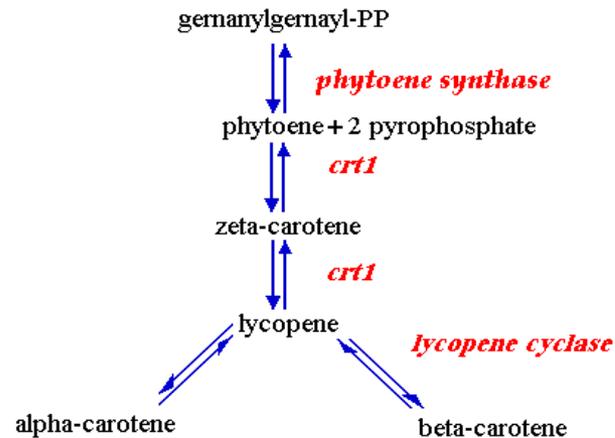
*Stevia rebaudiana, Tinospora cordifolia, Panax notogingsang etc*

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

# Terpenes



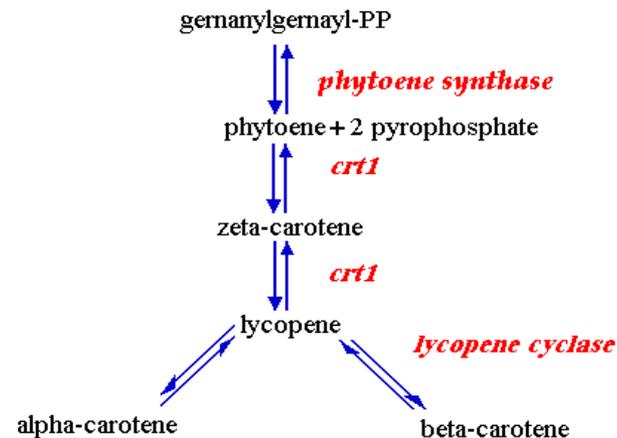
## Ingro Potrykus and Peter Beyer



*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....

## 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

# Case: Obesity Management

## Obesity leads to

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

**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



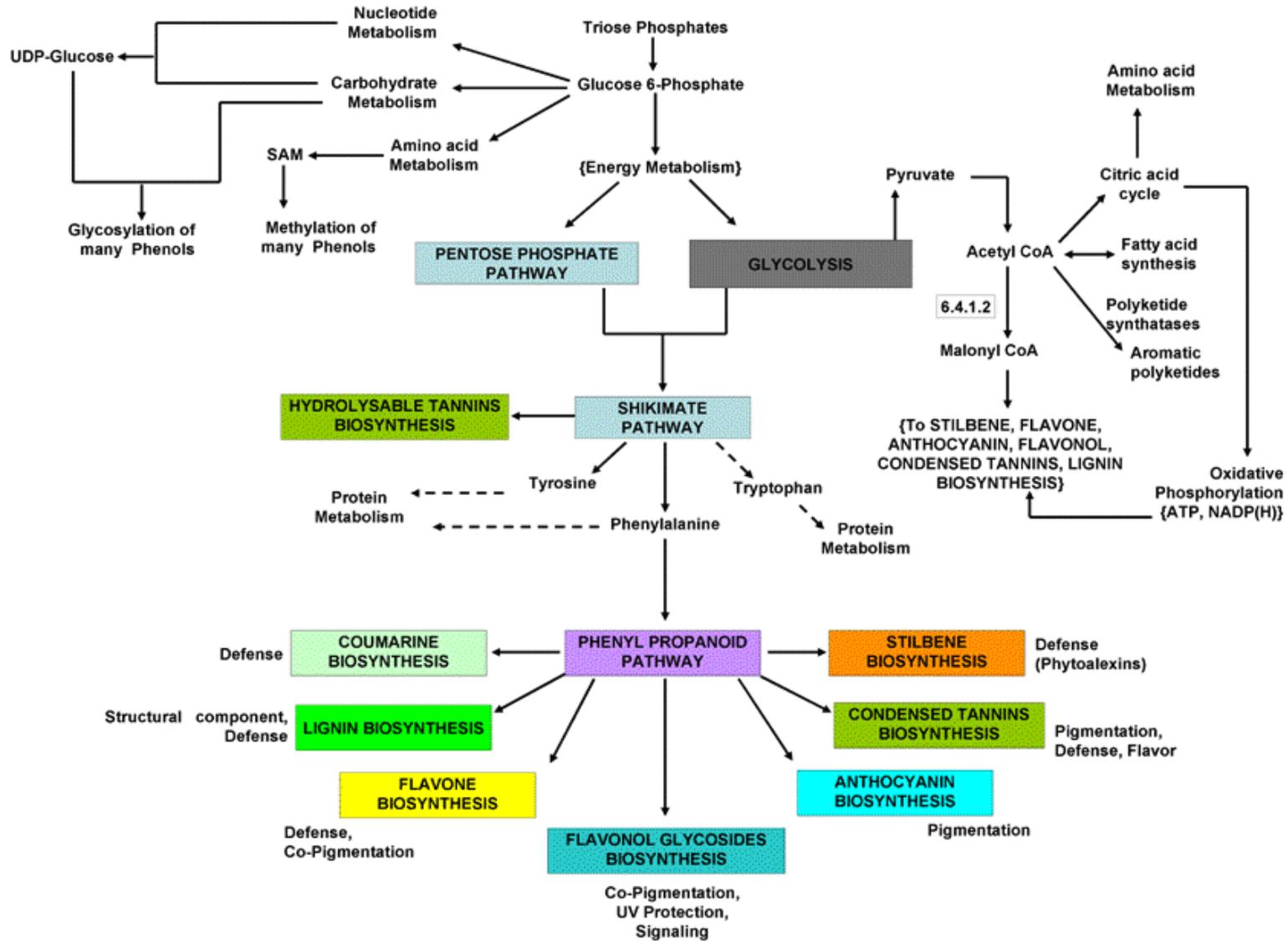
# Path through pathways...



# Phenylpropanoids

- Simple phenylpropanoids
- Lignans & Neolignans
- Flavonoids
- Tannins

OVERVIEW OF GENERAL PHENOL BIOSYNTHETIC PATHWAY IN GRAPE (*Vitis vinifera*) LEAVES





## *BioHorticulture Potential as NutraAgriculture...*

# 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

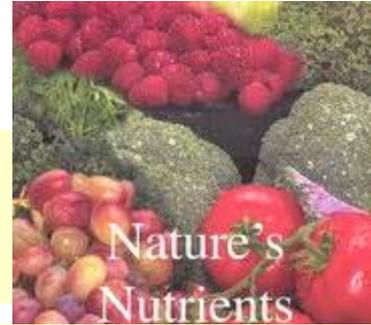


## R & D Challenge / Scope:

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

# 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

# $\beta$ -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



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.

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.

# *Daucus carota*

## Carrot

3839 Nucleotides    93 ESTs    1182 Proteins



Discover the power of Carrots

World Carrot Museum

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

Carrots nourish, they do not heal.

- The carrot gets its characteristic and bright orange colour from  **$\beta$ -carotene**, which is metabolised into vitamin A in humans when bile salts are present in the intestines.
- Also rich in **dietary fibre**, **antioxidants**, and **minerals**.
- Carrots absorb odours from apples and pears.
- Cooked carrots have a **Glycaemic Index of 49**, the scale invented to help in the treatment of diabetes. It is used to measure the rate at which blood sugar levels rise when a particular carbohydrate bearing food is ingested. Lower level GI foods, (those below 50 are seen as best), are more complex and hence digested more slowly, ensuring a longer feeling of satiety, longer term energy maintenance and keeping blood sugar levels constant.

# *Punica granatum*



239 Nucleotides

No EST

31 Proteins

- 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 **uroolithins** which have unknown biological activity *in vivo*.
- Other phytochemicals include **polyphenolic catechins**, **gallo catechins**, and **anthocyanins**, such as **prodelphinidins**, **delphinidin**, **cyanidin**, and **pelargonidin**.

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 Juice Components Could Stop Cancer from Spreading, Research Suggests



*Pomegranate and pomegranate juice Researchers at the University of California, Riverside have identified components in pomegranate juice that both inhibit the movement of cancer cells and weaken their attraction to a chemical signal that promotes the metastasis of prostate cancer to the bone. (Credit: iStockphoto/Deniz Kumral)*

ScienceDaily (Dec. 13, 2010) — Researchers at the University of California, Riverside have identified components in pomegranate juice that both inhibit the movement of cancer cells and weaken their attraction to a chemical signal that promotes the metastasis of prostate cancer to the bone. The research could lead to new therapies for preventing cancer metastasis.

Performed in the lab of Manuela Martins-Green, a professor of cell biology, the research was presented Dec. 12, 2010 at the 50th annual meeting of the American Society for Cell Biology taking place in Philadelphia.

# 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



113676 Nucleotides

362193 ESTs

76179 Proteins

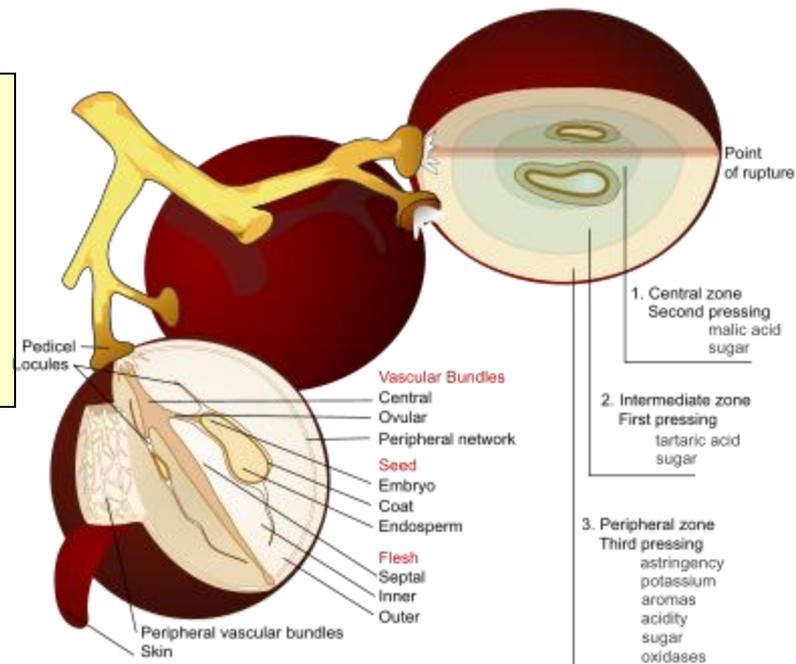
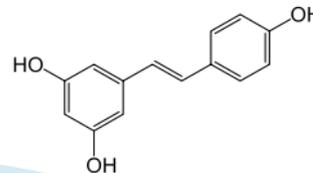
A grape is a **non-climacteric** fruit. It can be eaten raw or used for making jam, juice, jelly, vinegar, wine, grape seed extracts, raisins, and grape seed oil. It is also used in some kinds of confectionery.

• 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

# Grape Ingredient Resveratrol Increases Beneficial Fat Hormone

ScienceDaily (Jan. 10, 2011) — Resveratrol, a compound in grapes, displays antioxidant and other positive properties. In a study published this week, researchers at the UT Health Science Center San Antonio describe a novel way in which resveratrol exerts these beneficial health effects.

*Resveratrol stimulates the expression of adiponectin, a hormone derived from cells that manufacture and store fat, the team found. Adiponectin has a wide range of beneficial effects on obesity-related medical complications, said senior author Feng Liu, Ph.D., professor of pharmacology and member of the Barshop Institute of Longevity and Aging Studies at the Health Science Center.*

*Both adiponectin and resveratrol display anti-obesity, anti-insulin resistance and anti-aging properties*

# 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**.
- **Gene expression** has been studied in developing watermelon fruit (Wechter et al 2008).
- 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.

# Watermelon compounds may reduce CVD risk: Study

Nathan Gray, 18-Oct-2010

Watermelon extracts may be effective at naturally reducing pre-hypertension, according to new evidence from a pilot study.

*The research, led by food scientists at The Florida State University suggests that 6 weeks of L-citrulline extract from watermelon, reduced blood pressure and aortic wave reflection in middle aged individuals with pre-hypertension.*

## Important regulator

L-arginine is important in the formation of nitric oxide, a regulator of blood pressure through its effects on widening blood vessels. However, supplementation of L-arginine is not recommended for many people, as it can lead to nausea, gut discomfort, and diarrhoea.

*"Watermelon is the richest edible natural source of L-citrulline, which is closely related to L-arginine,"* said Dr. Figueroa.

Once ingested, L-citrulline from [watermelon](#) is converted into L-arginine without causing the problems associated with consumption of L-arginine.

# 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)*

# *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.

# Tomato compound may reduce blood lipid levels: Study

Nathan Gray, 10-Jan-2011

A nutrient which could help tackle the onset of vascular diseases by reducing blood lipid levels has been identified in tomatoes, according to a team of Japanese researchers.

The research, published in *Molecular Nutrition & Food Research*, suggests that an extracted compound, 9-oxo-octadecadienoic (9-oxo-ODA) works to reduce blood lipid levels and restore 'normal' fat metabolism in the liver, which could in turn be of benefit in preventing the onset of vascular diseases linked to high blood lipids – such as atherosclerosis.

Fractionated extracts of tomatoes containing the 9-oxo-ODA compound were shown increase the expression of specific genes involved in fatty acid oxidation and suppress the accumulation of triglycerides in mouse liver tissue. The researchers said that their findings are the first to identify such a compound from tomato.

Source: *Molecular Nutrition & Food Research*

Published online ahead of print, doi: 10.1002/mnfr.201000264

*"9-oxo-10(E),12(E)-octadecadienoic acid derived from tomato is a potent PPAR  $\alpha$  agonist to decrease triglyceride accumulation in mouse primary hepatocytes"*

Authors: Y.I. Kim, S. Hirai, H. Takahashi, T. Goto, C. Ohyane, T. Tsugane, et al.

# Tomato juice can reduce osteoporosis, claims study

Helen Glaberson, 23–Nov–2010

Tomato juice can significantly increase the presence of cell-protecting antioxidants that help to fight against osteoporosis, according to new research.

Writing in [Osteoporosis International](#), calcium researchers at the University of Toronto (UT) claim that 30mg of lycopene found in tomatoes – the equivalent to two glasses of [tomato juice](#) – is enough to help prevent the brittle-bone disease.

## Lycopenes

*Lycopene* is the red pigment in tomatoes and several fruits. According to the UT scientists, it is a potent carotenoid – a group of naturally occurring pigments essential for plant growth – with a high ability to quench singlet oxygen.

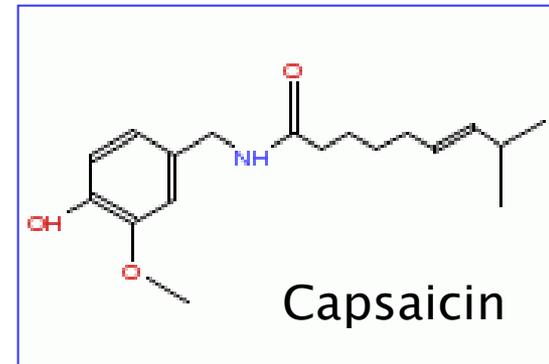
Due to this ability to decrease oxidative stress, lycopene has been associated with a decreased risk of chronic diseases.

# *Capsicum frutescens* (Chilli, lanka)

“Solanaceae”  $2n = 24$



- ▶ Habitat: Native to tropical America, tropics, africa and India.
- ▶ Origin: America
- ▶ Related spp. *Capsicum annum*
- ▶ Uses: Warming, stimulant, counter irritant and analgesic.
- ▶ Metabolic Pathways:
- ▶ Phytomolecules: Capsaicin, carotenoids, flavanoids, capsicidins (steroidal saponins in seed only).



# *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**.

# Compound in Celery, Peppers Reduces Age-Related Memory Deficits

ScienceDaily (Oct. 18, 2010) — A diet rich in the plant compound luteolin reduces age-related inflammation in the brain and related memory deficits by directly inhibiting the release of inflammatory molecules in the brain, researchers report. Luteolin (LOOT-ee-oh-lin) is found in many plants, including carrots, peppers, celery, olive oil, peppermint, rosemary and chamomile.

The new study, which examined the effects of dietary luteolin in a mouse model of aging, appears in the *Journal of Nutrition*.



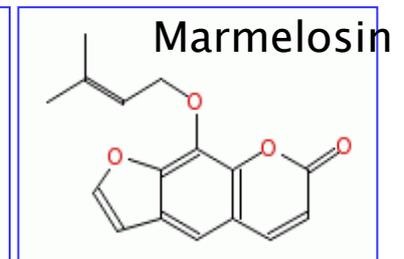
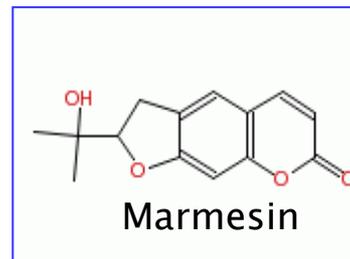
# *Aegle marmelos* (Bael, Bilwa, Sriphal, Bengal quince)

“Rutaceae”



- ▶ Habitat: Native to India, subcontinent and found commonly in central and southern India.
- ▶ Origin: India
- ▶ Related spp.:
- ▶ Uses: Astringent, reduces irritation in the digestive tract, in diarrhoea, dysentery, as demulscent and laxative, rich source of Vitamin C, in stomach pain and peptic ulcer.
- ▶ Metabolic Pathway : Alkaloidal amide
- ▶ Phytomolecules: Coumarins, flavonoids, tannins, caretinoids, Marmesin, Marmelosin & fixed oil.

Demand: 7084 tons (2004-05)NMPB



# *Phyllanthus emblica* (Amla, amloki, aonla, emblica)

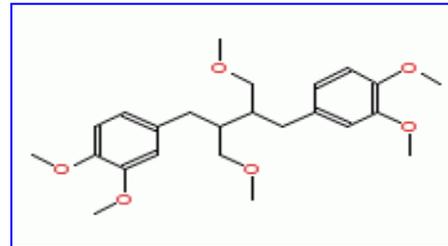
“Euphorbiaceae”

2n=



Demand: 41,782 tons (2004-05)NMPB

- ▶ Habitat: Native to India, subcontinent and found commonly in central and southern India.
- ▶ Origin: India
- ▶ Related spp.: *P.amarus* and *P.urinaria*
- ▶ Uses: In Ayurvedic drugs for treating liver and cardiovascular problems. It combines well with picrorrhiza in treating hepatitis B and other liver disorders. Antiviral against Hep B through inhibition of RNA replication, leaves are diuretic and lower BP and blood sugar.
- ▶ Metabolic Pathway: Lignans
- ▶ Phytomolecules: *Phyllanthus* leaves contain lignans (including phyllanthin and hypophyllantin), flavonoids and alkaloids. Fruits are a rich source of Vit C.



Phyllanthin

Found to possess potent immunomodulatory activity when used as a base in nutraceutical formulation

# *Zingiber officinale* (Ginger, Banada, Adrak, Ban adraka, Kadu sunthi )

“Zingiberaceae”

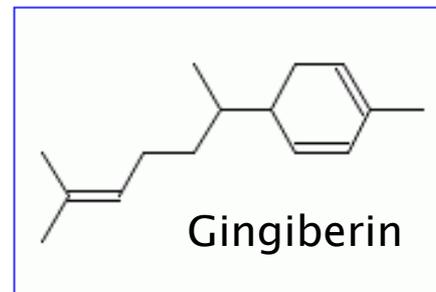


Production (tons) 484 (BCIL)

Demand (tons) 533

- ▶ Habitat: Through out India.
- ▶ Origin: Asia
- ▶ Related spp.: *Z.montanum*, *Z.purpureum*.
- ▶ Uses: In digestive problems, respiratory problems, as circulatory stimulant, in chilblains, cold, fever, cold sores, constipation, digestive upset and colic, atherosclerosis, morning sickness, nausea and motion sickness.
- ▶ Phytomolecules: Volatile oils–gingiberin, oleoresin (gingerol, shogaols).

Antiinflammatory and analgesic activity in standardized extract



# *Allium sativum*, Alicin (Diallyl thiosulfinate)

**Aged garlic shows blood pressure improvement benefits:  
Study**

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 alicin in garlic powder, and therefore more easily standardised.”*



# Metabolome Way...

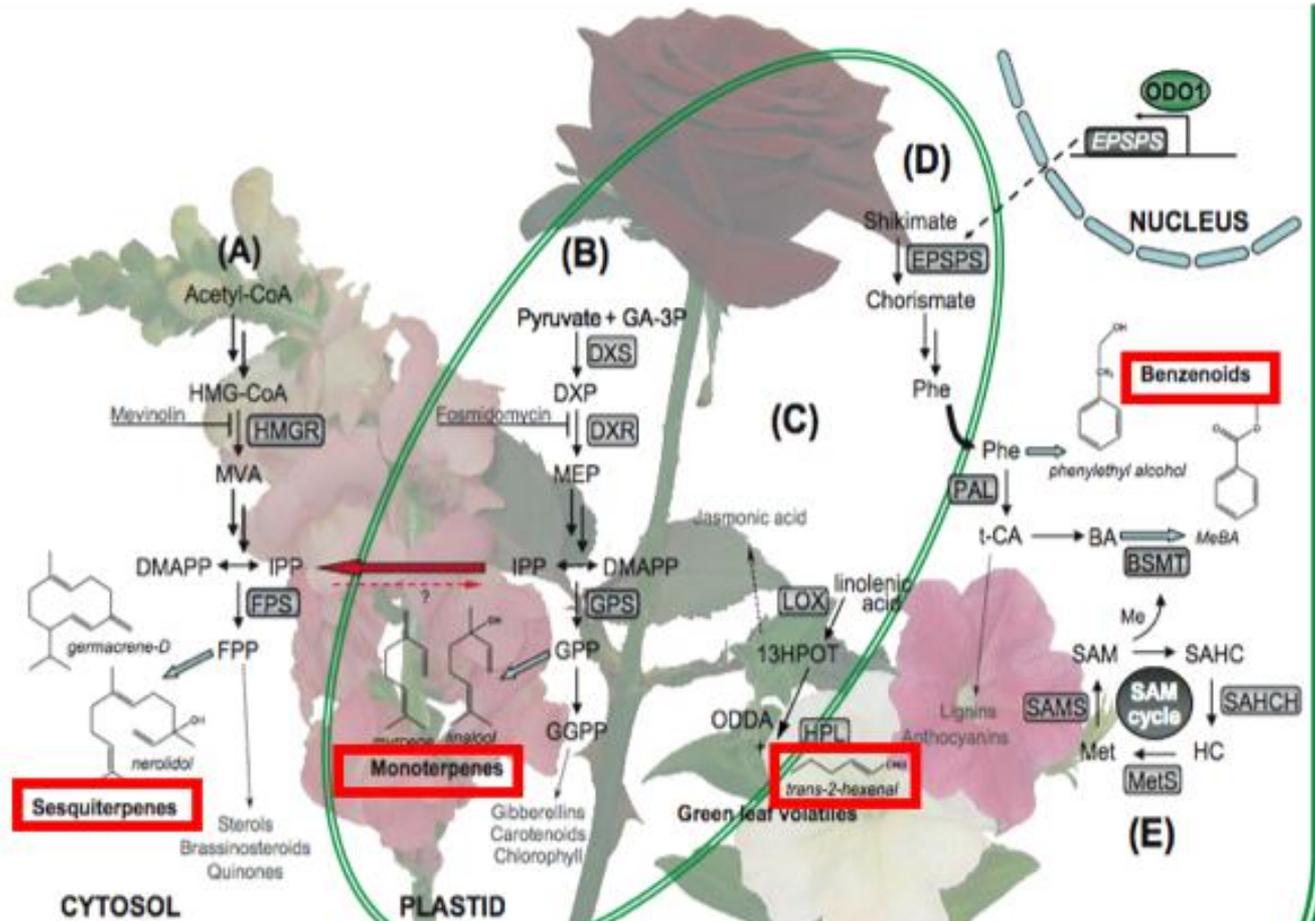
# Analogy-driven science: Petunia to Tomato

*Petunia hybrida* has emerged as the model of choice to study volatile benzenoid and phenylpropanoid synthesis, emission and regulation.

The knowledge obtained with this system is being applied to alter tomato fruit volatile production and thereby taste.

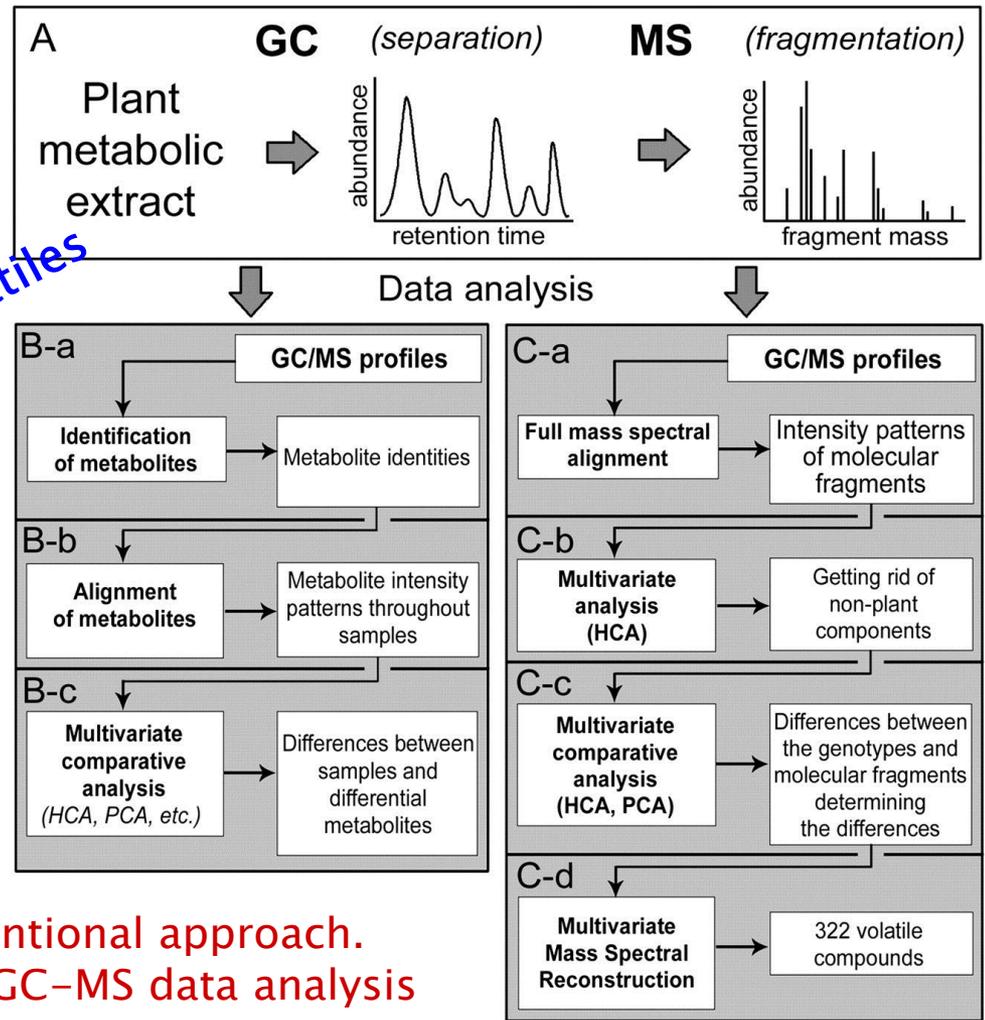
Tomato can also be used as a model system to study the role of terpenoids in its interaction with insects.

## Terpenoids, *E-2-hexenal* and Benzenoids



# GC-MS-based metabolomics

Large-Scale Profiling of Tomato Fruit Volatiles

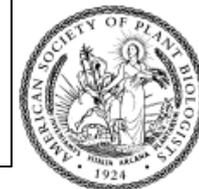
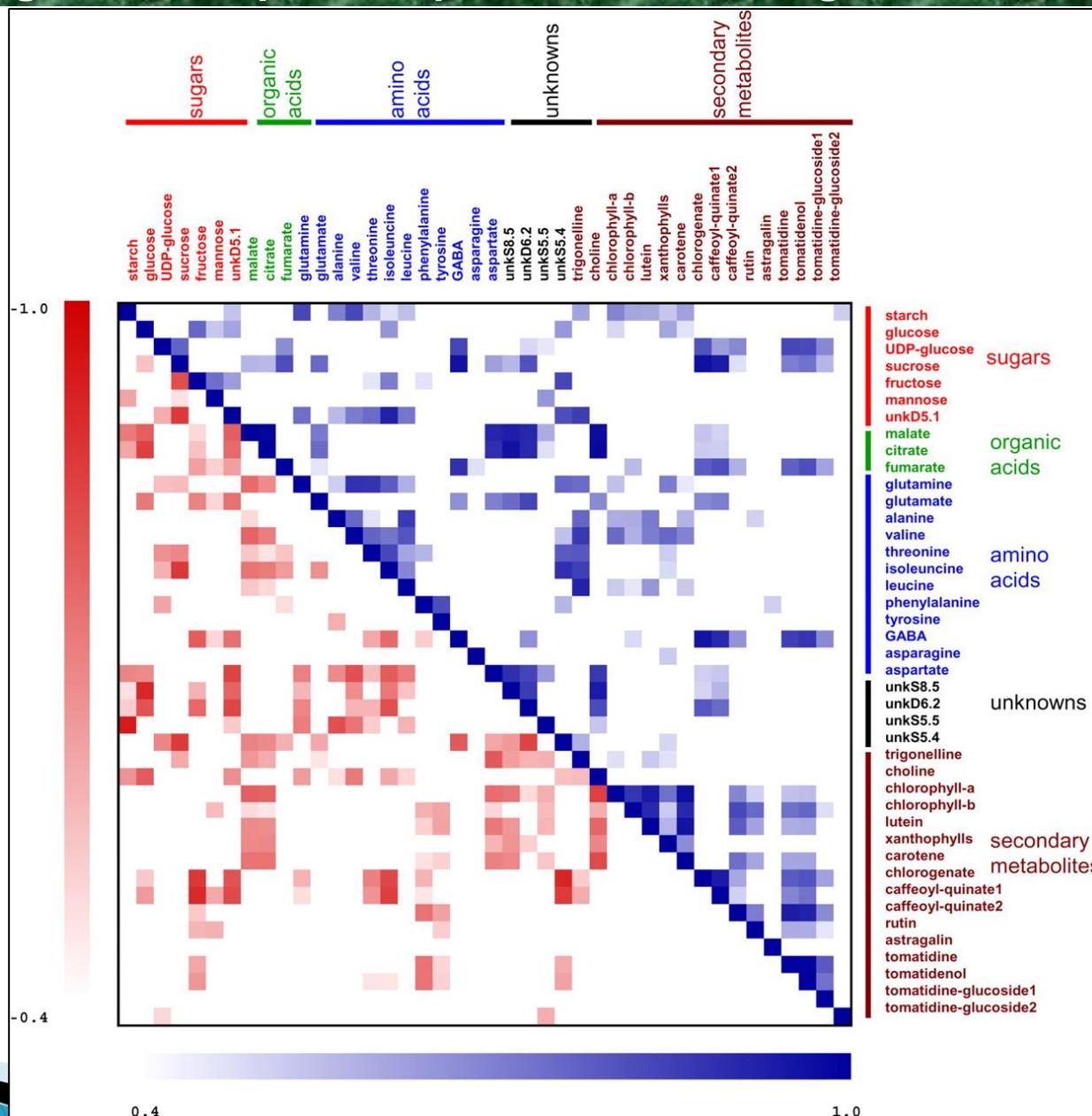


A, Analytical approach used. B, Conventional approach.  
C, Alternative, unbiased approach to GC-MS data analysis

Tikunov Y. et.al. Plant Physiol. 2005:139:1125-1137



# Heat map of metabolite × metabolite correlations for both mesocarp and locular tissue during the cell expansion phase of Ailsa Craig tomato fruits

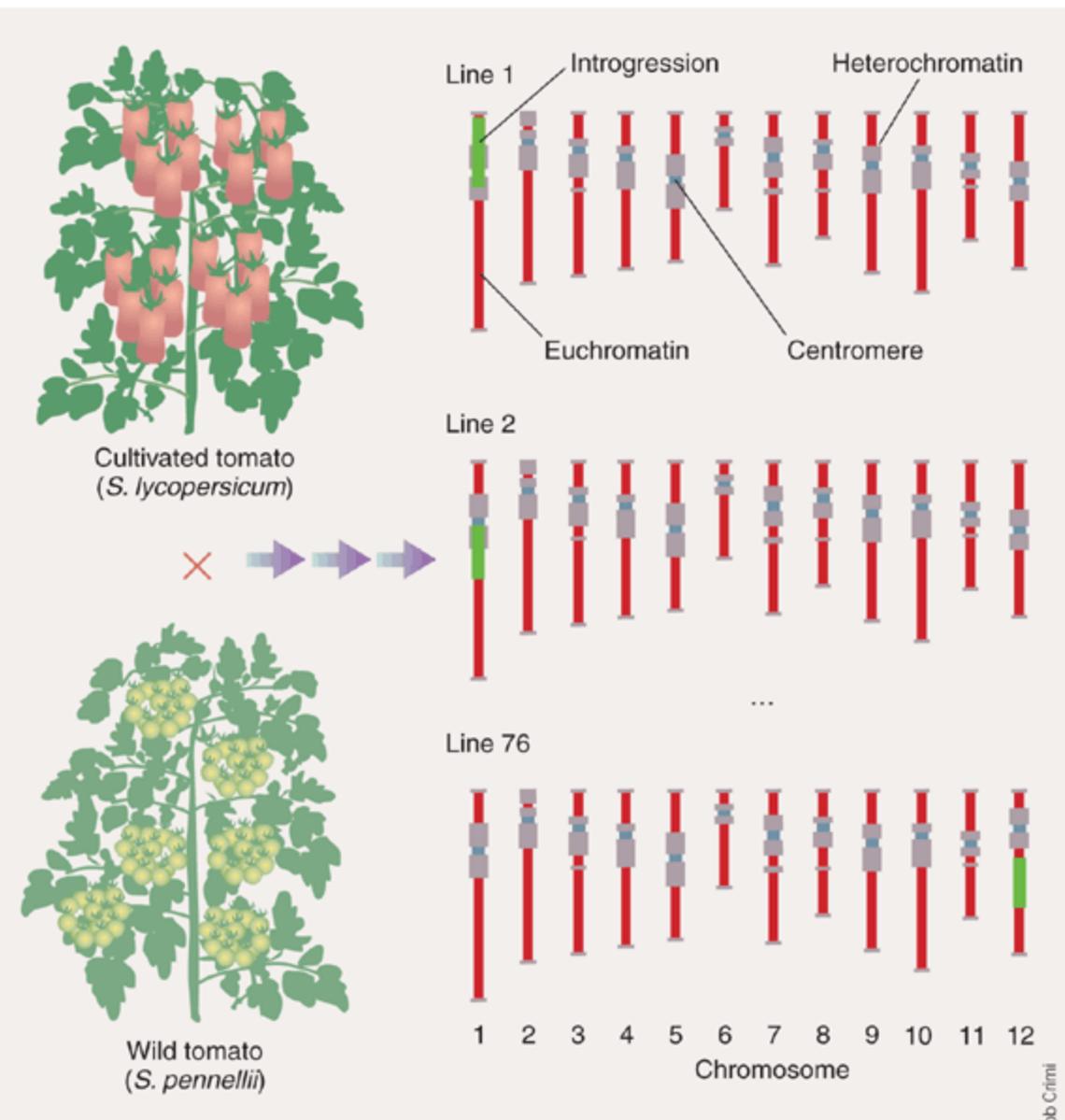


# Breeding new life into plant metabolism

Combined metabolic and phenotypic analysis of tomato introgression lines provides chemical markers of fruit quality

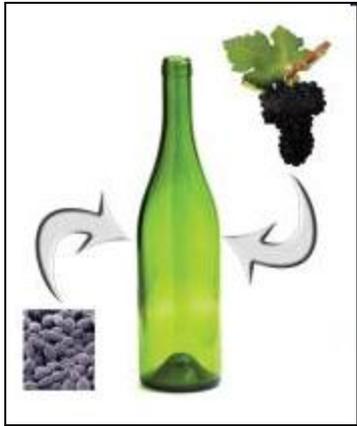
Giovannoni JJ, *Nature Biotechnology* 24: 418 – 419 (2006)

Metabolic genomics

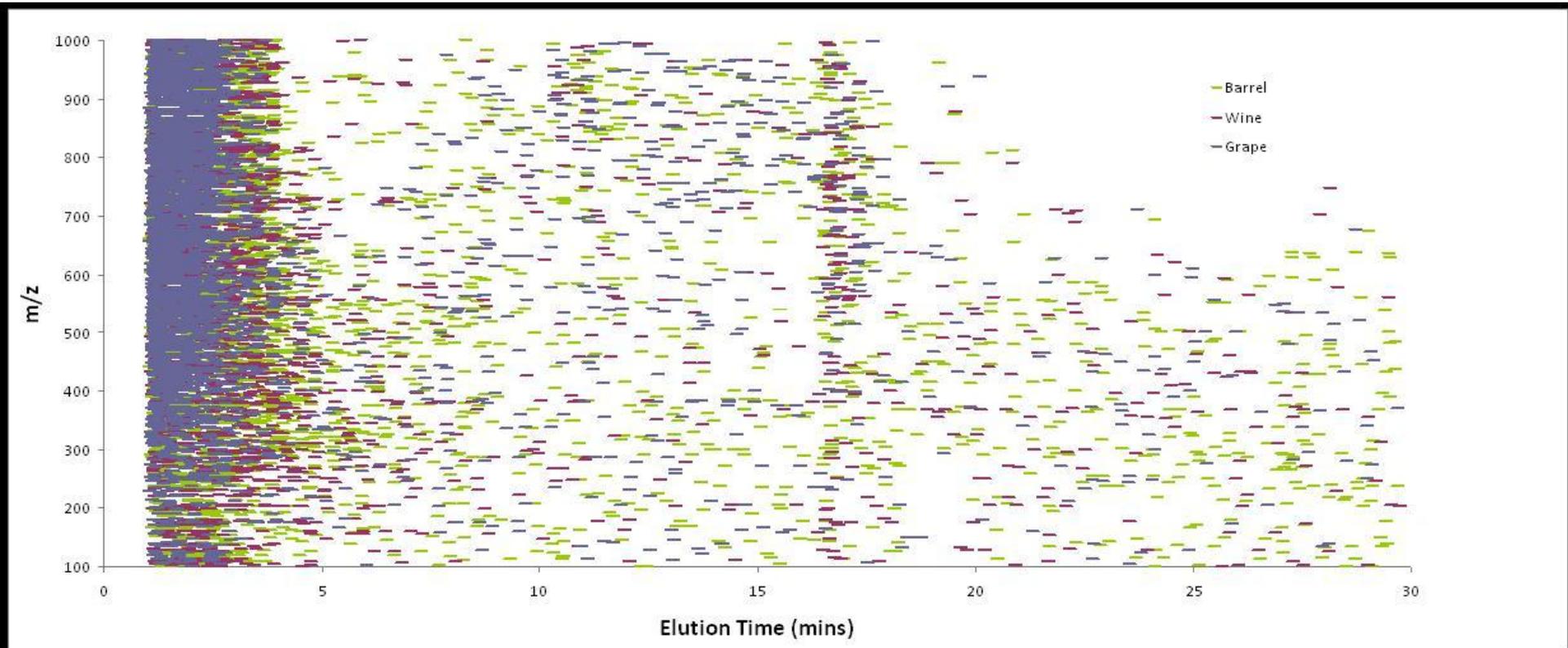


Metabolic and fruit-quality QTLs have been mapped in tomato introgression lines previously developed through multiple rounds of self- and back-crossing (to the cultivated parent) between an elite cultivar, *Solanum lycopersicum* var. Roma, and a wild or 'ancestral' tomato plant, *Solanum pennellii*, to generate 76 independent introgression lines of tomato plants harboring chromosome segments from the wild relative. Selection of specific, homozygous, single, overlapping chromosome introgressions in this population both simplifies QTL localization and defines linked DNA markers for use in crop improvement.

# Comparative Grape, Wine and Barrel Metabolomics



The wine metabolome equates to the complete chemical makeup of wine, and includes compounds originating from the grape (as influenced by variety, rootstock, climate and viticultural practices), microorganisms occurring in the vineyard and all stages of the winemaking process, additives, as well as maturation and processing treatments.

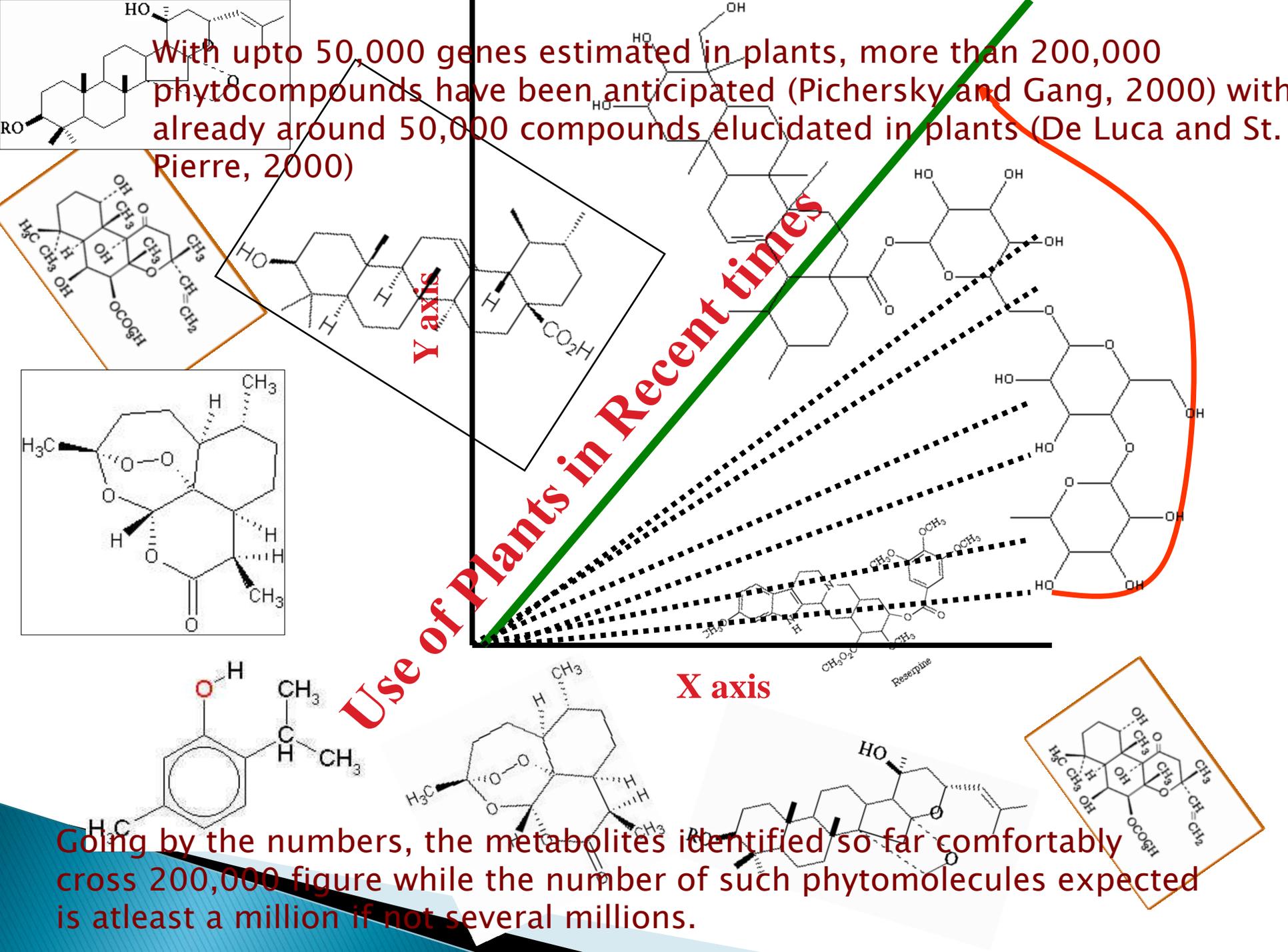


With upto 50,000 genes estimated in plants, more than 200,000 phytochemicals have been anticipated (Pichersky and Gang, 2000) with already around 50,000 compounds elucidated in plants (De Luca and St. Pierre, 2000)

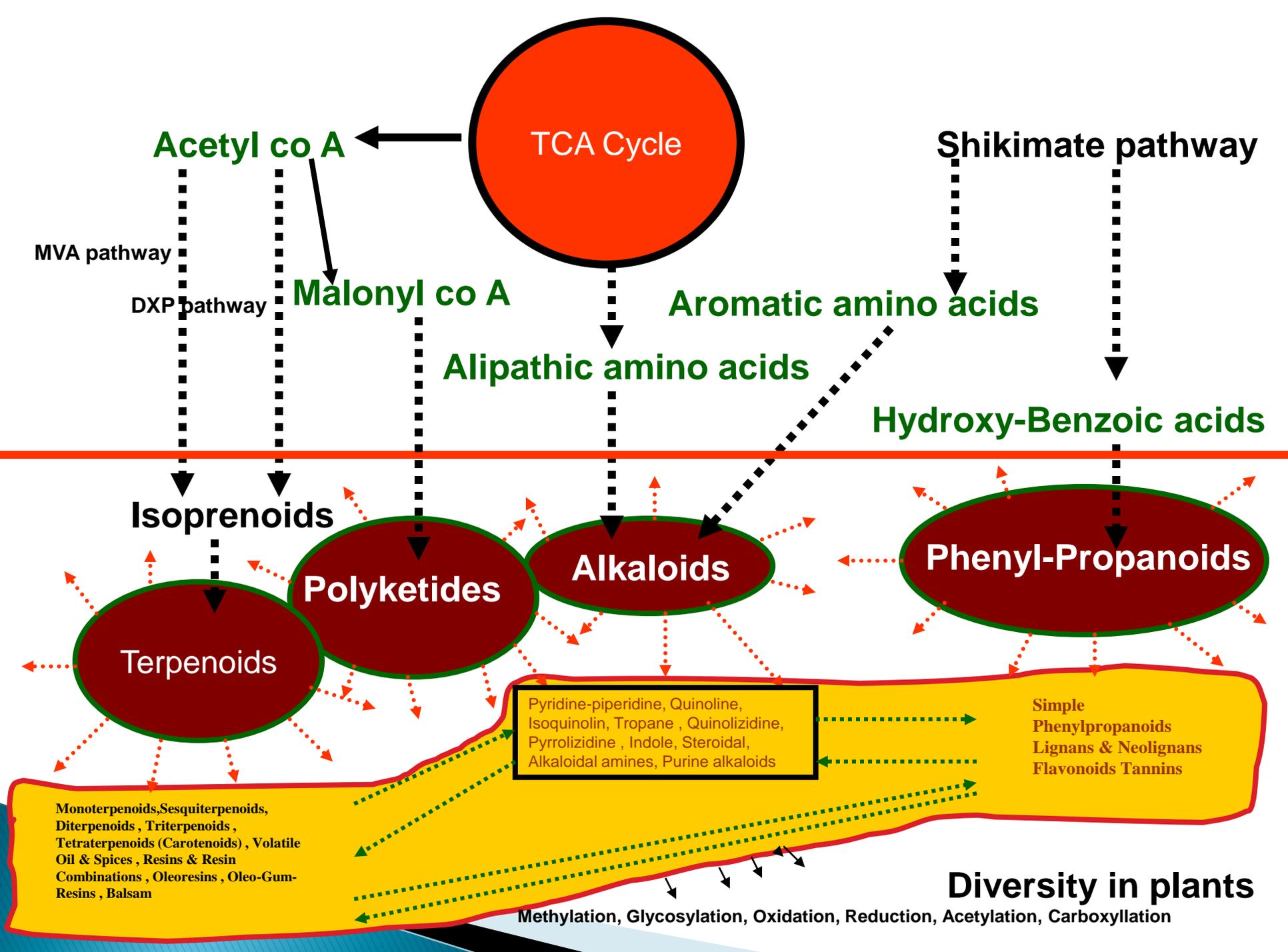
**Use of Plants in Recent times**

Y axis

X axis

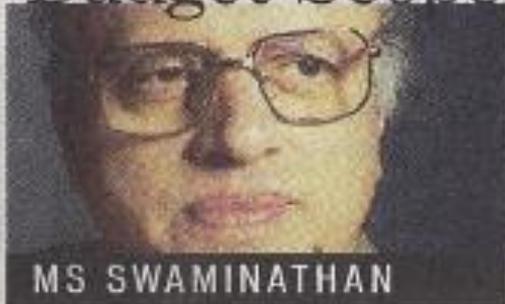


Going by the numbers, the metabolites identified so far comfortably cross 200,000 figure while the number of such phytomolecules expected is atleast a million if not several millions.



# Food security act is necessary for sustainable development

## Budget Scope



MS SWAMINATHAN

■ [letters@hindustantimes.com](mailto:letters@hindustantimes.com)

2010-20 HAS been declared as the decade of innovation. An essential pre-requisite for achieving the position of an innovation superpower is providing

the age of 5 in the country are under-weight. To become an innovation superpower, we must adopt a whole-life cycle approach in our plans for food for all and for ever. We must not deceive ourselves into believing that by establishing 14 innovation universities, we will become an innovation superpower. Nutrition and education are the pathways to a happy country.

Food security at the level of each individual child, woman and man is the first requirement for a healthy and productive life. Jawaharlal Nehru had said in

availability of food in the market, which is a function of internal production and if necessary imports; access to food, which is a function of adequate purchasing power and absorption of food in the body, which is a function of clean drinking water, sanitation and primary healthcare.

The proposed National Food Security Act is being designed to ensure economic access to food through legal entitlement, while factors relating to production and absorption are proposed to be included as essential enabling provisions.

# Getting Food Security Right

The Act on food security must mandate technology-based intervention and well-defined monitoring



**T NANDA KUMAR**  
FORMER UNION SECRETARY,  
FOOD & AGRICULTURE

**T**he first issue in food security is India's Hunger index. The Global Hunger Index released by International Food Policy Research Institute (IFPRI) places India 67th in rankings with a score of 24.1, far below China and below Sri Lanka, Pakistan and Nepal. According to FAO, about 25% of world's undernourished live in India. The proposed Food Security Act is seen as the key instrument of intervention to remedy this situation.

The Global Hunger Index of IFPRI is calculated as an average of (1) proportion of the

gress needs to be made on all three counts whatever be their comparative weights in the equation. The most important, of course, has to be undernourishment.

Given the fact that the government has given a commitment to introduce a Food Security Bill (FSB) in Parliament, thereby giving the citizens an enforceable right to food, what are the key issues to be addressed?

A 'right' to citizens is an 'obligation' for the government. The government will have to ensure that people get safe and nutritious food, and preferably food of their choice, at all times. Ensuring the overall availability of food has remained the responsibility of the government (in the perception of state governments, that of the Union government) even without the FSB. Given the progress made in agricultural production over the past few decades and the continuing levels of hunger and malnutrition, ec-



SALAM

diversion, or poor quality, consistent efforts to make any significant change in the performance of PDS have failed to make a dent. It is almost axiomatic that the proposed legislation should address the 'delivery deficit' and place specific responsibilities on the administrative machinery, be it panchayat, district or state. How is this to be done?

A strong technology-based

adequate decentralisation will have to take place.

Another important concern is the capability for procuring enough grains for distribution. In case physical delivery of grains is insisted upon for eligible categories, all states (with a few exceptions) will have to make a clear commitment to procure a certain minimum level of food-grains. Failure to do so will place the responsibility at the

mation. It is probably the right time to move towards a scheme of "purchase for progress" (P4P) articulated by the World Food Programme. A decentralised purchase and distribution programme at the district level (if possible at the tehsil/block level) will not only enthuse the farmers of the region, but may also take care of the possible adverse impact on agriculture. However, in such a programme, strong monitoring systems have to be put in place to prevent "recycling".

While an enforceable right is "power" in the hands of the people, the objective of the government should, rightly, be to set up efficient mechanisms to deliver on the promises without fail. Litigation in this case is best avoided.

If this is to happen, effective delivery and convergence of programmes at the operational level have to be the top priority. The implementation module will have to provide for effective choices to imple-

# The way forward...

**Integrative Genomics Approach**  
**Metabolome Diversity Utilisation**  
**Multidisciplinary Research**  
**Innovation Driven Technologies**

# Acknowledgement..

**NutraHelix Biotech Pvt Ltd**

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**Team CIMAP (CSIR)**

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## Translating ideas into products and processes



- ✓ Novel Food Matrixes
- ✓ Millet Based Formulations
- ✓ Gluten Free Formulations
- ✓ Dietary & Soluble Fibres
- ✓ Pre- & Pro-biotics
- ✓ Antioxidants & Immunity Boosters
- ✓ Lipids & Carbohydrates for Health
- ✓ Health Drink Formulations
- ✓ Functional Foods for Liver & Cardiovascular Health
- ✓ Metabolism Promoters & Gut Functioning Aids
- ✓ Microbial & Enzymatic Supplements
- ✓ Medicinal Plants based Phytochemicals and Bioactives
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(Chief Mentor & Director)
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