



## Health prospects of phytochemicals in horticultural crops

Tanushree Sahoo<sup>1\*</sup>, Kaluram<sup>2</sup>

<sup>1</sup> Ph.D. Scholar, Division of Fruits and Horticultural Technology, ICAR-Indian Agricultural Research Institute, New Delhi, India

<sup>2</sup> Ph.D. Scholar, Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India

### Abstract

A healthy eating strategy with increased consumption of plant-based foods plays important roles in the prevention of chronic diseases, such as heart disease, cancer, stroke, diabetes, Alzheimer's disease, cataracts, and age-related function decline. Phytochemicals are naturally occurring chemicals, other than traditional nutrients, found in plants (fruits, vegetables, grains *etc.*), which when consumed in food, elicits the responses in the human metabolism, leading to improvement in human health. These bio actives have antioxidant, anti-inflammatory, anti-diabetic and anticancerous properties. The anti-carcinogenic effect of polyphenols is attributed to their antioxidant properties, as well as their capability to modulate the activity of enzymes, block hormone receptors and lower the activity of mutagens. Polyphenols also protect blood vessels, reduce the aggregation of blood platelets and lower the LDL-cholesterol level in blood. Therefore, the food basket with diverse horticultural produce will be a boon to enhance nutritional security of our future population.

**Keywords:** health prospects, phytochemicals, horticultural crops

### Introduction

Healthy life is dream of all human kind, but few chronic diseases have emerged as the major social challenges for the twenty-first century. Therefore, a healthy eating strategy consisting of ample plant-based foods will play vital role in prevention of such diseases, viz. heart disease, cancer, stroke, diabetes, cataracts, and age-related function decline. The oldest and most popular claim “*an apple a day keeps the doctor away!*” certainly justifies that horticultural crops are the richest source of phytochemicals. These phytochemicals are naturally occurring chemicals, other than traditional nutrients, found in plants which when consumed, elicits the responses in the human metabolism, and consequently leading to improved human health. Phytochemicals, phytonutrients, & phytonutraceuticals have been used interchangeably to describe chemical compounds derived from fruits and vegetables that have health promoting properties. Epidemiological studies have shown that consumption of fruits and vegetables is negatively associated with the morbidity and mortality of cardio- and cerebrovascular diseases and certain types of cancers. The antioxidants contained in fruits and vegetables, including carotenoids, flavonoids, hydrolysable tannins *etc.* are supposed to play an important role in the prevention of these diseases. (Ness and Powles, 1997) <sup>[3]</sup>.

### Idea of phytochemicals

Father of Medicine, Hippocrates suggested, “*Let food be your medicine and your medicine be food*” in 5<sup>th</sup> century B.C. By 20<sup>th</sup> century B.C, most of the research in human nutrition focused primarily on “*Traditional food nutrients*”. This interest was justified since food components were essential to prevent deficiency related diseases *e.g.*, Scurvy. Subsequent epidemiological evidences link fruits and vegetables consumption to decreased risks of various degenerative diseases. French paradox is a widely cited example of the protective effects of specific dietary phytochemicals. France has lower incidence of CVD than other population with

similar diet and lifestyle risk factors (*e.g.*, high fat diets, smoking *etc.*). Extensive research has led to broad agreement that it is due to the controlled consumption of “Red wine. Studies indicated that phenolic phytochemical of Grape is responsible for it.

### Classification of phytochemicals

Harborne, (1999) classified phytochemicals based on chemical structures:

1. Terpenoids
2. Polyphenolics
3. Alkaloids
4. Nitrogen containing compounds

*Terpenoids* are further classified as:

#### a) Carotenoid terpenoid

- Saponins
- Perillyl alcohol
- Terpenoel
- Terpene limonoids

#### b) Non-carotenoid terpinoid

- Carotene --- (orange carotenoid)
- Zeaxanthin --- ( yellow carotenoid)
- Lutein --- ( yellow carotenoid )
- Lycopene --- (red carotenoid)

Beecher (1999) classified phytochemicals based on biological activities:

1. Carotenoids (carotene, cryptoxanthin, lutein, lycopene, zeaxanthin)
2. Glucosinolates (sulforaphane, indole-3-carbinol)
3. Inositol phosphates (phytate, inositol tetra & penta phosphate)
4. Cyclic phenolics (chlorogenic acid, ellagic acid & coumarins)
5. Phytoestrogens (isoflavones, diadgenin, genistein, & lignans)
6. Phytosterols (campesterol, beta sitosterol & stigmasterol)

7. Phenols (flavonoids)

8. Protease inhibitors

9. Saponins

10. Sulfides &amp; thiol

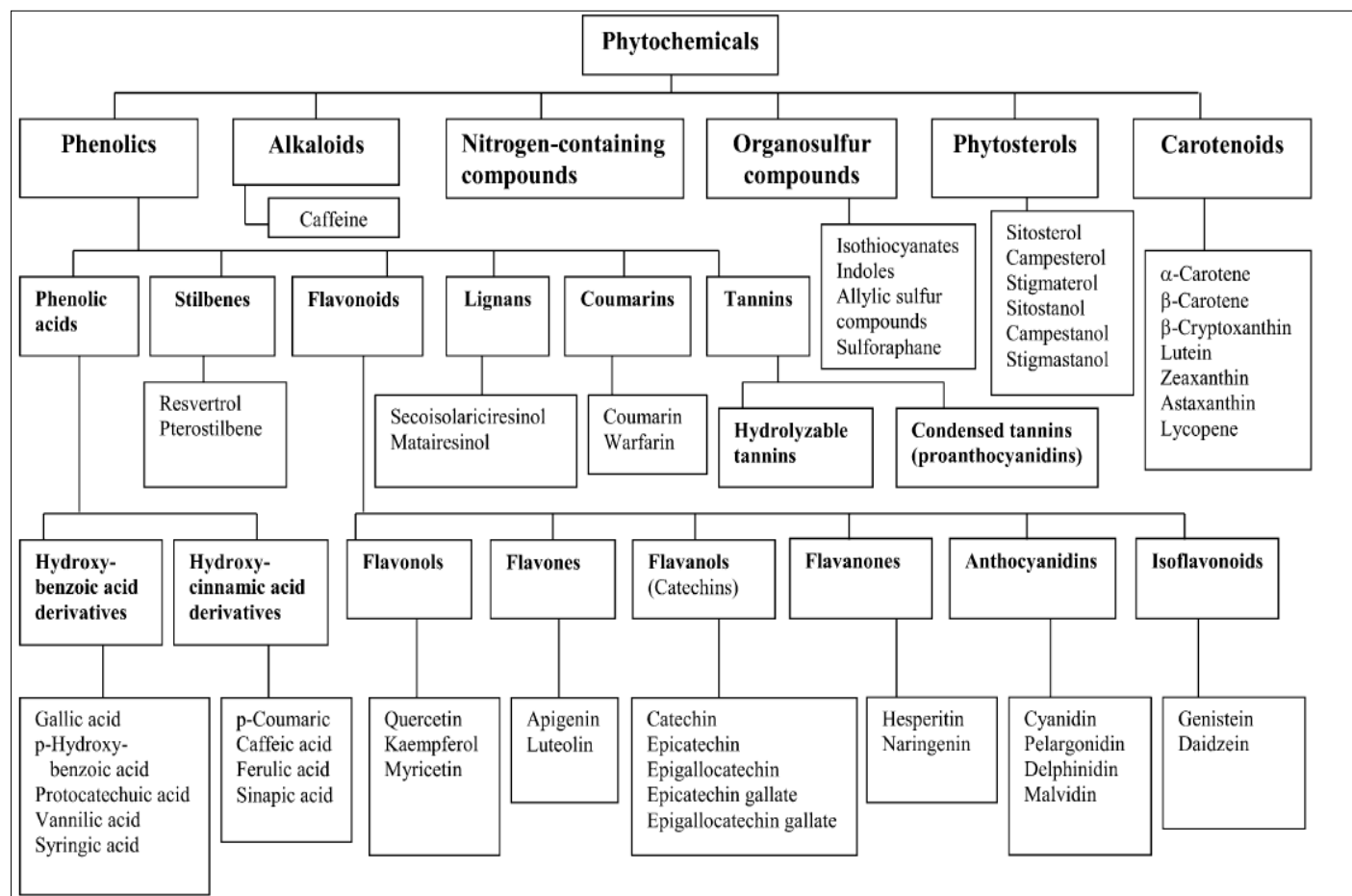


Fig 1

### Classification of Phytochemicals

#### How these phytochemicals actually protect us and promote our health?

Phytochemicals provide health promoting effects by following ways:

- Antioxidant Activity e.g. flavonoids, carotenoids
- Anti-cancer Effects e.g. glucosinolates, isothiocyanate
- Cardiovascular Protection e.g. thiosulfates, phenolics
- Anti-inflammatory Effects e.g. phenolics
- Neurological Function e.g. terpenoids, anthocyanins
- Urinary Tract Health e.g. folate

#### Antioxidant Activity (AOX)

The accumulated damage to DNA, proteins & lipids by Reactive Oxygen Species (ROS) is a precursor for the numerous degenerative diseases including-

- Cancers
- Cardiovascular diseases (CVD)
- Certain Neurological diseases
- Immune system decline
- Cataracts
- Aging process itself

ROS including hydrogen peroxide, superoxide anion, hydroxyl radicals peroxy radicals are generated within the cells either from internal source (normal metabolic processes) or from external sources such as UV radiation and xenobiotic agents like tobacco smoke, air pollutants etc. it is estimated

that in humans the DNA in each cell sustains 10,000 oxidative "hits" per day.

The protection against cellular oxidative damage may be provided by consuming antioxidant-rich fruits and vegetables.

- The biological role of carotenoids (one of the antioxidants) has been classified into 3 categories

#### 1. Function

- In human, only known function is linked with their vitamin A activity.

#### 2. Action

- Potential antioxidant activity.
- Inhibition of mutagenesis & transformation.
- Inhibition of macular degeneration, cataracts.
- Decrease risks of some cancers & CVD.

#### 3. Association

- Diets rich in tomato are rich in carotenoid – lycopene associated with low risks of stomach & rectal Cancers.

#### Anti-Cancer Effects

There are mainly three stages of carcinogenesis

1. Initiation
2. Promotion
3. Progression.

The various phytochemicals act as blocking agents during initiation stage either by:

**Inhibiting activation of procarcinogens**

Cytochrome P450 enzymes are a battery of Phase I enzymes that have been shown to metabolically activate chemical carcinogens such as nitrosamines and aflatoxins. Phytochemicals are known to inactivate these enzymes Trapping ROS (H<sub>2</sub>O<sub>2</sub>, Superoxide anion, Hydroxyl radical Peroxyl radical) and protecting against cellular oxidative damage.

**Enhancing Phase II detoxification**

Phase II enzymes (e.g., Glutathion-S-transferase, Quinone reductase, NAD PH reductase) are capable of conjugating with activated carcinogens & convert them into water soluble compounds that can be easily excreted out by our kidney. Phytochemicals such as isothiocyanates (sulforaphane, indole-3-carbinol) are potent inducers of these enzymes. Recent evidence also suggests that isothiocyanates may regulate cancer cell development by promoting apoptosis or programmed cell death.

**Cardiovascular protection**

Phytonutrients such as Beta-Carotene, Allyl sulfides, Polyphenols, Anthocyanins, Folic acid, Vitamin C Vitamin E etc. impact this chronic disease via multiple mechanisms: Improved vascular compliance; reduced blood pressure; Decreased platelet aggregation; improved lipoprotein profile; Low Density Lipoprotein (LDL) oxidation protection; reduced lipid peroxidation.

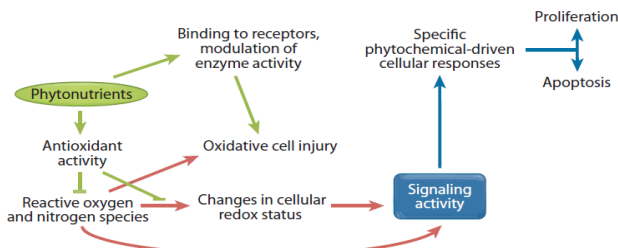


Fig 2

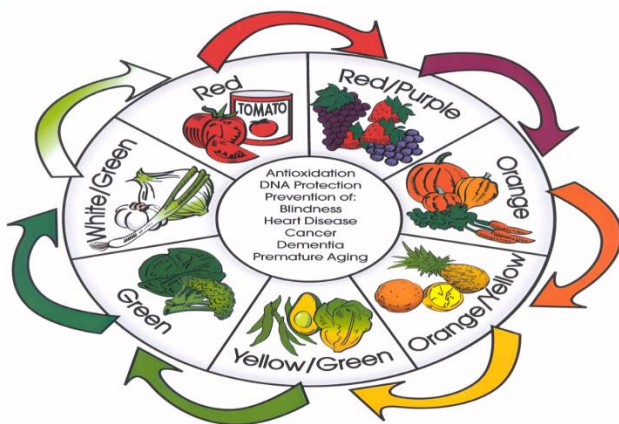


Fig 3

**Colour Wheel of Phytochemicals**

Dr. Heber and Susan Bowerman (Center for Human Nutrition, Los Angeles) originated a seven color system organized as a color wheel. This colour wheel will help the

common people to identify and know the roles of different colour group of foods rich in phytochemicals.

**Red**

Red coloured fruits and vegetables offers phytochemicals such as: Quercetin, lycopene anthocyanins phytoene, phytofluene, ellagic acid lignans, vitamin E, carotenoids. The main sources of these phytochemicals are:

Red apples cherries, berries, cranberries, pomegranates, watermelon, beets, red, peppers, tomatoes etc.

**Main Health benefits**

- These provide antioxidants & anti-aging effects.
- Helps maintain memory function, healthy heart, urinary tract health,
- Lowers the risk of some cancers.

**Green**

Green coloured fruits and vegetables offers phytochemicals such as, lutein, Glucosinolates, sulforaphane, folacin, Indole-3 Carbinol, Folic Acid, vit. E Fiber, Isothiocyanates Zeaxanthin.

The main sources of these phytochemicals are Avocados, Mustard green, Honeydew Melon, Limes, Artichokes, Broccoli, Brussel Sprouts, Lettuce, Spinach, Okra, Kiwi etc.

**Main Health benefits**

- Shields against breast, colon and prostate cancer
- Promote vision health, strong bones and teeth.
- Lutein reduces the risks of Age-Related Macular Degeneration (ARMD) by 43% and that of colon cancer by 17 %.

**White, TAN, and Brown**

- Alliin, the main photochemical in this group is responsible for heart health, lowering Cholesterol levels, and lowering some risks of cancer
- Fresh garlic bulb contains the compound alliin, which accounts for the anticancer activity.
- Other Phytochemicals found in onion & garlic are
- Flvanoids & Flvanols- quercetin kaempferol,myricetin luteolin. Allyl sulfides, ajoene, aspirin, (acetyl salicyclic acid), warferin.

**Yellow/Orange**

They offer phytochemicals such as Vitamin C, folacin, carotenoids, coumarins, phenolic acid, rutin, bioflavoniods, fiber, kaempferol, quercetin liminoids, limonene lemcitrol, limocitrin, isolimocitrol, luteolin, sinensetin, diosmin etc.

**Blue/Purple**

They are rich in photochemicals such as anthocyanins and phenolics, e.g., resveratrol (in grape skin). It helps to maintain memory function, prevent Urinary tract infection and it lowers the risk of some cancers. They also have antioxidant and anti-aging effects. Nasunin, (anthocyanin from eggplant) inhibit brain cell lipid peroxidation caused by free radicals. Thus protect from cerebrovascular disorders.

## Negative sides of phytochemicals

Table 1

PHYTOCHEMICAL	SOURCE	ROLE
Anthocyanin	Pear, peach, plum, apple, cherry, sweet orange, grape	Improvement of vision, neuroprotective effects
Caffeine	Coffee, tea	Used for weight loss, & in cure of diabetes, headache
Catechins( Flavanols)	Apple, grape, green tea	Vasodilation, improved blood flow to brain, improved insulin sensitivity
Coumarins	calendula	Treatment of asthma and lymphedema
Curcumin	turmeric	Anti-inflammatory, anti-mutagenic Antiseptic, hepatoprotective
Carotenoids	Carrot, saffron, paprika, celery, parsley	Neutralization of free radicals
Quercetin	Onion, garlic	Treatment of heart diseases, cataract, arterosclerosis, cancer
Isothiocyanates	Mustard, radish, turnip, cabbage	Decrease cancer risk

Studies on animals containing large amounts of phytochemicals have negative results. For instance, non-water soluble phytochemicals like carotenoids, resveratrol etc. if consumed excessively will accumulate in fatty tissues, and can act adversely. Carotenoids are generally nontoxic,

but high beta carotene consumption by smokers results in high risk of lung cancer & cardiovascular diseases. Apart from this, some deleterious steroidal alkaloids in solanaceous vegetables e.g., solanine

Table 2

PHYTOCHEMICAL	SOURCE	ROLE
Lycopene	Tomato, pepper	Neutralization of free radicals
Sulphur compounds	Onion, garlic, asafoetida, chives, leek	Decrease in LDL cholesterol Anti-cancer property
Glucosinolates	Cruciferous vegetables like cabbage, cauliflower,	Anti-cancer property
Flavone glycosides	Citrus, strawberry	Reduction in blood pressure
Flavanones(Hesperidin, naringin)	Citrus fruits	Lymphedema, cancer
Monoterpenes	Cumin, fennel, caraway	Prevention of cancer
sesquiterpenes	Cinnamon, juniper, ginger, turmeric	Cardiovascular & cancer diseases, anti-inflammatory
Hydroxy benzoic acid	Mushroom, red wine	Anti-bacterial, anti-viral Anti-diabetic
Cinnamic acid	cinnamon	Anti-diabetic, anti-malarial, decrease blood cholesterol

### What's next for Phytochemicals?

Research is the key step. In present scenario some research exists but need more definite results. Most of the research works have been reported from Western Countries. However, not many initiatives have been taken by Indian Researchers in these aspects concerned with phytochemicals.

In near future, research needs to answer questions like what, how, & which type of phytochemicals provides health benefits? It is equally necessary to establish the safety of use. How much is too much? And most importantly, to determine an effective dosage that protects against particular disease.

### Conclusion

The evidences gathered from these studies, have increased awareness of food phytochemicals & have renewed consumer's interest on the possibility of managing personal

health & disease risks through lifestyle, & in particular dietary choices.

- Each horticultural crop contains a unique combination of different colours.
- Each color (phytochemical) offers a different health benefit. Eat all the colors to *et al.* The benefits. No one color does it all!
- Till date 3,000 phytochemicals have been identified. Many more are yet to be identified & name.
- They provide first-line defense against chronic diseases by multiple mechanisms.
- The overall benefit cannot be attributed to one component, rather, due to a synergism between them.

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