Antioxidant capacity of phytochemicals and their effects.

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Abstracts: - Antioxidants are compounds that inhibit oxidation. Oxidation is a chemical reaction that can produce free radicals, thereby leading to chain reactions that may damage the cells of organisms. **Antioxidants** such as thiols or ascorbic acid (vitamin C) terminate these chain reactions. **Vitamin C**, commonly known as **ascorbic acid**, is the most powerful water-soluble antioxidant found in blood plasma. Phytochemicals are naturally occurring antioxidants that could be considered as one of the most promising materials used in human diets in various forms.

Keywords: - Antioxidants, ROS, Free-radical, Phytochemical.

Introduction: -They are sometimes called "free-radical scavengers. "The sources of antioxidants can be natural or artificial. Certain plant-based foods are thought to be rich in antioxidants. Plant-based antioxidants are a kind of phytonutrient, or plant-based nutrient. The body also produces some antioxidants, known as endogenous antioxidants. Antioxidants that come from outside the body are called exogenous. Free radicals are waste substances produced by cells as the body processes food and reacts to the environment. If the body cannot process and remove free radicals efficiently, oxidative stress can result. This can harm cells and body function. Free radicals are also known as reactive oxygen species (ROS). Factors that increase the production of free radicals in the body can be internal, such as inflammation, or external, for example, pollution, UV exposure, and cigarette smoke. Oxidative stress has been linked to heart disease, cancer, arthritis, stroke, respiratory diseases, immune deficiency, emphysema, Parkinson's diseases, and other inflammatory or ischemic conditions.

Antioxidants in recent years, there has been a great deal of attention toward the field of free radical chemistry. Free radical's reactive oxygen species and reactive nitrogen species are generated by our body by various endogenous systems, exposure to different physiochemical conditions or pathological states. A balance between free radicals and antioxidants is necessary for proper physiological function. If free radicals overwhelm the body's ability to regulate them, a condition known as oxidative stress ensues. Free radicals thus adversely alter lipids, proteins, and DNA and trigger a number of human diseases. Hence application of external source of antioxidants can assist in coping this oxidative stress. Synthetic antioxidants such as butylated hydroxytoluene and butylated hydroxyanisole have recently been reported to be dangerous for human health. Thus, the search for effective, nontoxic natural compounds with antioxidative activity has been intensified in recent years help neutralize free radicals in our bodies, and this is thought to boost overall health. The recent growth in the knowledge of free radicals and reactive oxygen species (ROS) in biology is producing a medical revolution that promises a new age of health and disease management. [1] It is ironic that oxygen, an element indispensable for life, [2] under certain situations has deleterious effects on the human body. [3] Most of the potentially harmful effects of oxygen are due to the formation and activity of a number of chemical compounds, known as ROS, which have a tendency to donate oxygen to other substances. Free radicals and antioxidants have become commonly used terms in modern discussions of disease mechanisms. [4]

Free Radicals: -

A free radical can be defined as any molecular species capable of independent existence that contains an unpaired electron in an atomic orbital. The presence of an unpaired electron results in certain common properties that are shared by most radicals. Many radicals are unstable and highly reactive. They can either donate an electron to or accept an electron from other molecules, therefore behaving as oxidants or reductants. [5]

The most important oxygen-containing free radicals in many disease states are hydroxyl radical, superoxide anion radical, hydrogen peroxide, oxygen singlet, hypochlorite, nitric oxide radical, and peroxynitrite radical. These are highly reactive species, capable in the nucleus, and in the membranes of cells of damaging biologically relevant molecules such as DNA, proteins, carbohydrates, and lipids. [6] Free radicals attack important macromolecules leading to cell damage and homeostatic disruption. Targets of free radicals include all kinds of molecules in the body. Among them, lipids, nucleic acids, and proteins are the major targets.

Production of free radical in human body: -

Free radicals and other ROS are derived either from normal essential metabolic processes in the **human body** or from external sources such as exposure to X-rays, ozone, cigarette smoking, air pollutants, and industrial chemicals. **Free radicals** are unstable molecules that can damage the cells in your **body**. They form when atoms or molecules gain or lose electrons. ... For example, when your **body** uses oxygen, it creates **free radicals** as a by-product and the damage caused by those **free radicals** is called "oxidative stress." These substances include fried foods, alcohol, tobacco smoke, pesticides, air pollutants, and many more. Free radicals can cause damage to parts of cells such as proteins, DNA, and cell membranes by stealing their electrons through a process called oxidation. Avoid high glycemic foods, or foods that are rich in refined **carbohydrates** and **sugars**.

They are more likely to generate free radicals. Limit **processed meats** such as **sausages**, **bacon** and salami. They contain preservatives, which leads to the production of free radicals Damage to DNA by **free radicals** can result in mutations and promote cancer. **Free radicals** can also oxidise low-density lipoprotein or LDL (“**bad**” cholesterol), making it more likely to get trapped on the artery walls, clogging blood vessels and leading to cardiovascular disease. Air pollution **causes free radical** reactions, as **does** the cosmic radiation that swipes at us as we fly in a plane. Exercise **causes** oxidative stress, but those who get in shape become highly efficient at detoxifying **radicals**, more than offsetting the extra **radicals** generated.[3]

Some internally generated sources of free radicals are [7]

- Mitochondria
- Xanthine oxidase
- Peroxisomes
- Inflammation
- Phagocytosis
- Arachidonate pathways
- Exercise
- Ischemia/reperfusion injury

Some externally generated sources of free radicals are:

- Cigarette smoke
- Environmental pollutants
- Radiation
- Certain drugs, pesticides
- Industrial solvents
- Ozone

Phytochemicals work as Antioxidants: -

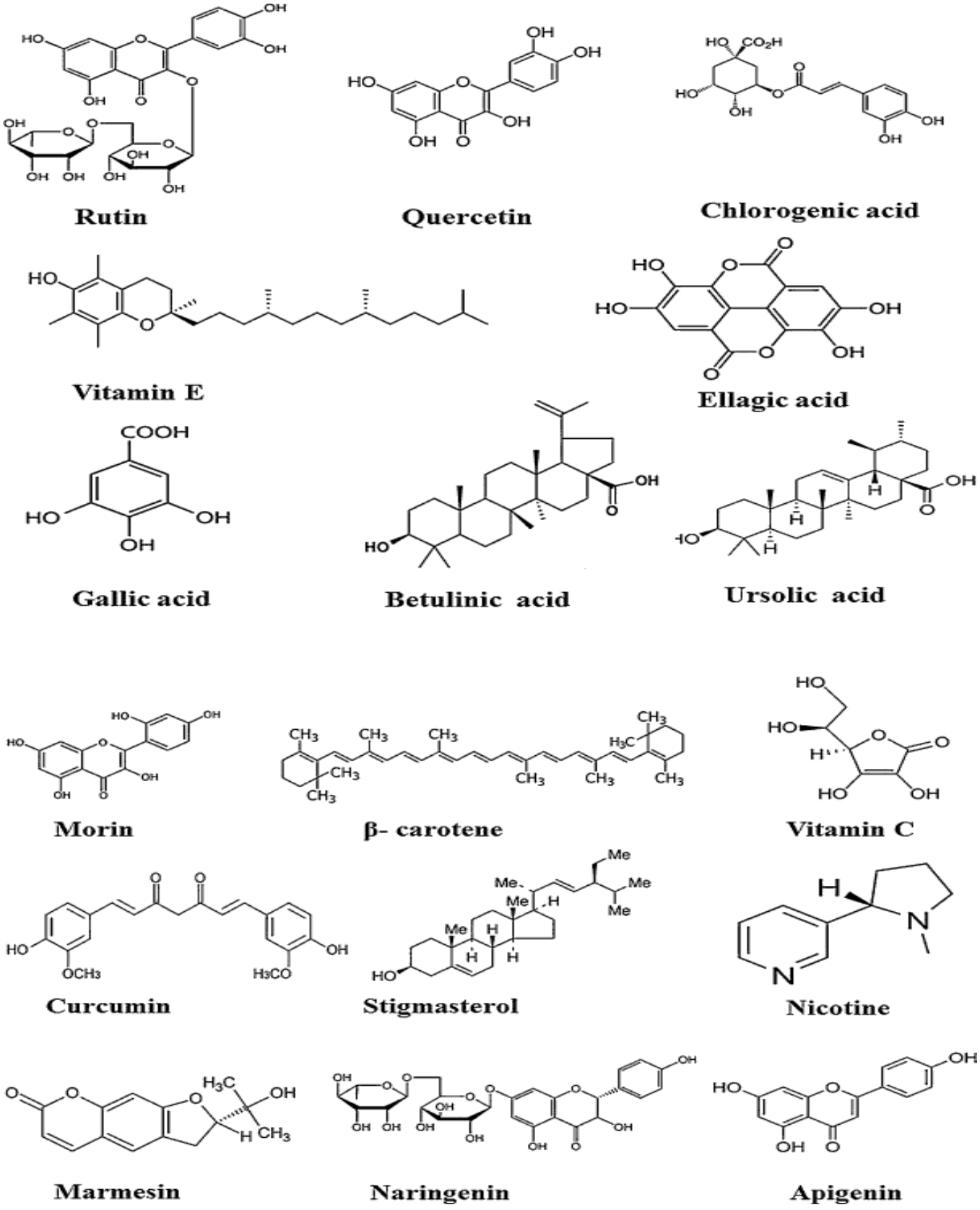
Antioxidant phytochemicals exist widely in fruits, vegetables, cereal grains, edible macrofungi, microalgae, and medicinal plants [8,9]. Common fruits, such as berries, grape, Chinese date, pomegranate, guava, sweetsop, persimmon, Chinese wampee and plum are rich in antioxidant phytochemicals [10,11,12]. In addition, wild fruits, such as the fruits of *Eucalyptus robusta*, *Eurya nitida*, *Melastoma sanguineum*, *Melaleuca leucadendron*, *Lagerstroemia indica*, *Caryota mitis*, *Lagerstroemia speciosa* and *Gordonia axillar* also have high antioxidant capacities and total phenolic contents [13]. Besides, fruits wastes (peel and seed) also contain high contents of antioxidant phytochemicals, including catechin, cyanidin 3-glucoside, epicatechin, gallic acid, kaempferol, and chlorogenic acid [14]. Some vegetables, such as Chinese toon bud, loosestrife, penile leaf, cowpea, caraway, lotus root, sweet potato leaf, soy bean (green), pepper leaf, ginseng leaf, chives, and broccoli are found to have high antioxidant capacities and total phenolic contents [15]. Among cereal grains pigmented rice, such as black rice, red rice and purple rice, possess high contents of antioxidant phytochemicals (flavones and tannins) [16]. Among selected Chinese medicinal plants, the highest antioxidant capacities and phenolic contents are found in *Dioscorea bulbifera*, *Eriobotrya japonica*, *Tussilago farfara* and *Ephedra sinica* [17], and several flowers including edible and wild ones also have high contents of antioxidant phytochemicals [18].

Polyphenols and carotenoids are the two main kinds of antioxidant phytochemicals, and they contribute the most to the antioxidant properties of foods/plants. For example, β-carotene, quercetin, myricetin and kaempferol are the main antioxidant phytochemicals found in Cape gooseberry [19], and anthocyanins and ellagitannins are the major antioxidant compounds among the phytochemicals of strawberry [20]. In addition, flavonoids isolated from *Euterpe oleracea* pulp present an important antioxidant activity measured by oxygen radical absorbance capacity [21]. Natural polyphenols are the most abundant antioxidants in human diets, and their radical scavenging activities are related to substitution of hydroxyl groups in the aromatic rings of phenolics [22]. The plant variety, geographic region, growing season, and storage can all influence the concentrations of polyphenols in food [23]. Dietary polyphenols could be classified into five classes: flavonoids, phenolic acids, stilbenes, tannins and coumarins.

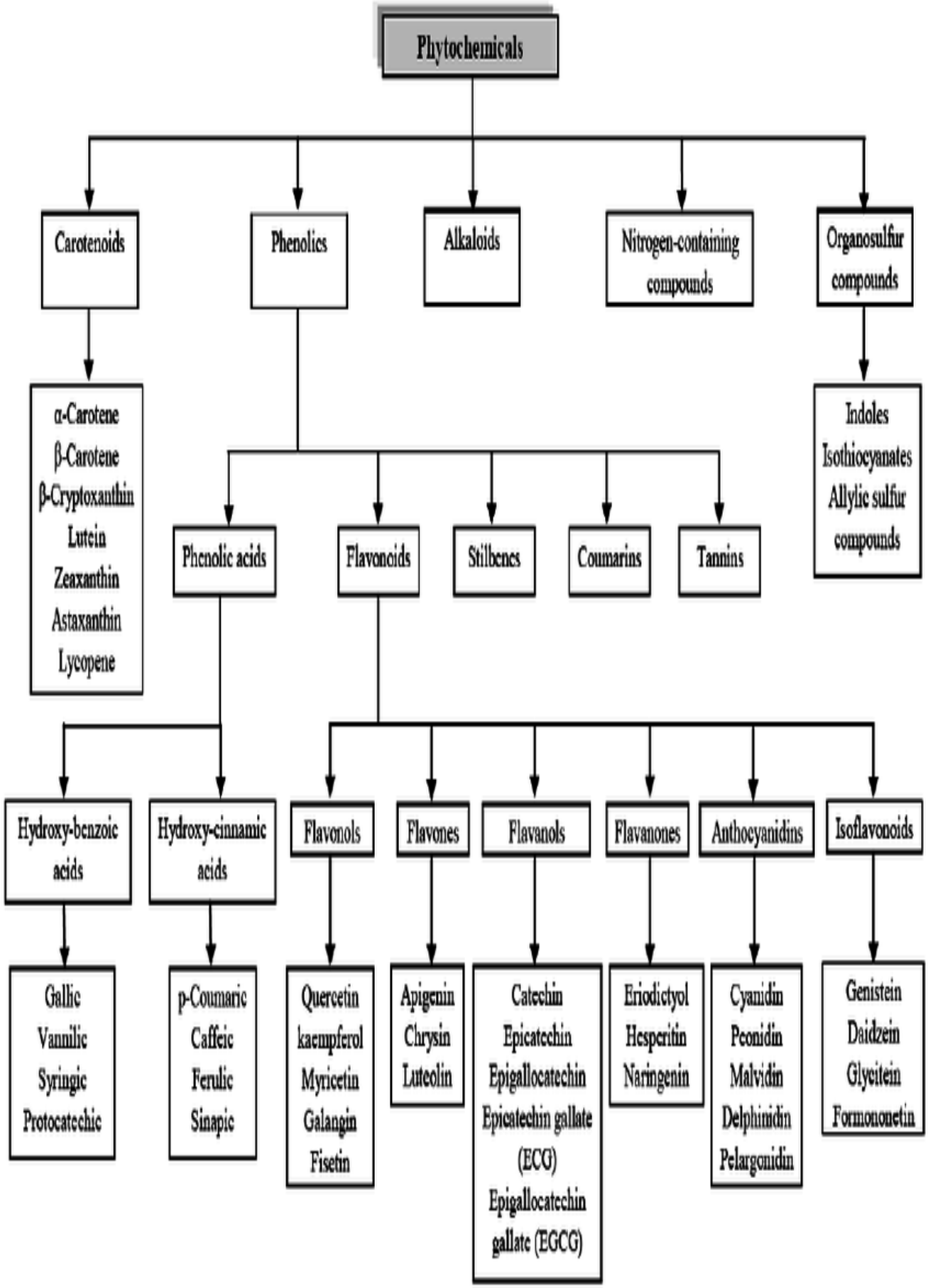
Flavonoids can be further categorized as flavonols, flavones, flavanols, flavanones, anthocyanidins, and isoflavonoids [24]. Total phenolic content and total antioxidant activity in phytochemical extracts of different fruits may have a direct relationship. When the fruits contain higher total phenolic contents, they possess stronger antioxidant activity [25]. For example, the scavenging activity of grape seed extract against ABTS radical was strongly linked with the level of phenolic compounds [26].

Carotenoids are a group of phytochemicals that are responsible for the yellow, orange and red colors of the foods. α-Carotene, β-carotene, lycopene, lutein and cryptoxanthin are the main carotenoids in the diet and human body, and fruits and vegetables are the major sources of carotenoids in human diet. For example, tomato is rich in lycopene, which is also responsible for its characteristic red colour.

Structures of some Antioxidants Phytochemicals: -



Some Chemical Structures of Phytochemicals Work as Antioxidants.


Phytochemicals
Carotenoids
Phenolics
Alkaloids
Nitrogen-containing compounds
Organosulfur compounds
α-Carotene
β-Carotene
β-Cryptoxanthin
Lutein
Zeaxanthin
Astaxanthin
Lycopene
Indoles
Isothiocyanates
Allylic sulfur compounds
Phenolic acids
Flavonoids
Stilbenes
Coumarins
Tannins
Hydroxy-benzoic acids
Hydroxy-cinnamic acids
Flavonols
Flavones
Flavanols
Flavanones
Anthocyanidins
Isoflavonoids
Gallic
Vanillic
Syringic
Protocatechic
p-Coumaric
Caffeic
Ferulic
Sinapic
Quercetin
kaempferol
Myricetin
Galangin
Fisetin
Apigenin
Chrysin
Luteolin
Catechin
Epicatechin
Epigallocatechin
Epicatechin gallate (ECG)
Epigallocatechin gallate (EGCG)
Eriodictyol
Hesperitin
Naringenin
Cyanidin
Peonidin
Malvidin
Delphinidin
Pelargonidin
Genistein
Daidzein
Glycitein
Formononetin

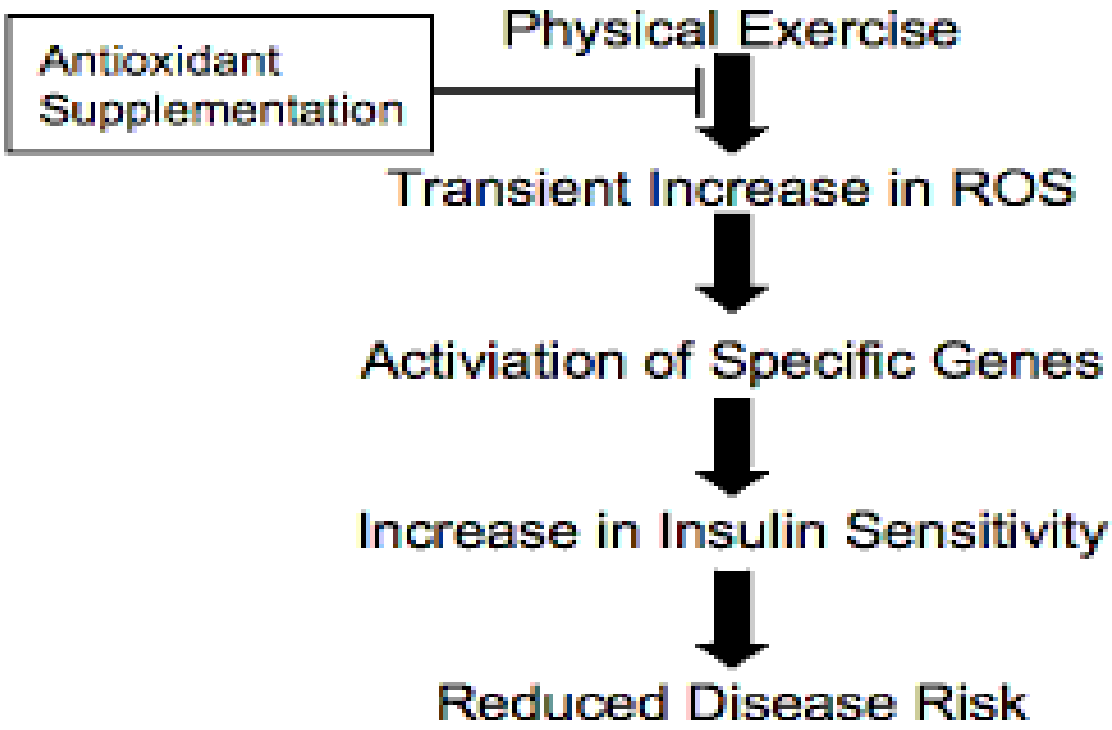
Antioxidant capacity: -

Total **antioxidant capacity** (TAC) is an analyte frequently used to assess the **antioxidant** status of biological samples and can evaluate the **antioxidant** response against the free radicals produced in a given disease.

Antioxidant Capacity of Herbs, Spice & Cocoa* (*ORAC Measurment, dried unless otherwise noted)	Common Usage Level	Antioxidant Level
Spice, Hebs & Cocoa		
Basil	1/2 teaspoon	1,689
Basil-Fresh	1 Tablespoon	481
Chili Powder	1/2 teaspoon	546
Cilantro-Fresh	1 Tablespoon	510
Cinnamon	1/2 teaspoon	6,688
Cloves	1/2 teaspoon	7,861
Cocoa Powder	1 Teaspoon	4,250
Cumin	1/2 teaspoon	1,920
Curry	1/2 teaspoon	1,213
Garlic	1/2 teaspoon	168
Ginger	1/2 teaspoon	725
Marjoram	1/2 teaspoon	675
Mustard Seed	1/2 teaspoon	725
Oregano	1/2 teaspoon	5,000
Oregano-Fresh	1 teaspoon	700
Paprika	1/2 teaspoon	450
Parsley	1/2 teaspoon	1,850
Pepper-Balck	1/2 teaspoon	688
Peppermint-Fresh	1 teaspoon	700
Tarragon Fresh	1 teaspoon	777
Thyme-Fresh	1/2 teaspoon	688
Tumeric	1/2 teaspoon	3,975
Source: Compiled from United States Department of Agriculture Report "Oxygen Radical Absorbance Capacity of Selected Foods" November 2007; Adapted by Kardea to more common usage rates.		

Effect of Antioxidants on Health: -

A diet high in **antioxidants** may reduce the risk of many diseases (including heart disease and certain cancers). **Antioxidants** scavenge free radicals from the **body** cells and prevent or reduce the damage caused by oxidation. The protective **effect of antioxidants** continues to be studied around the world.



Antioxidants are substances that may protect your cells against free radicals, which may play a role in heart disease, cancer and other diseases. Free radicals are molecules produced when your **body** breaks down food or when you're exposed to tobacco smoke or radiation.

Conclusion: -

Free radicals damage contributes to the etiology of many chronic health problems such as cardiovascular and inflammatory disease, cataract, and cancer. **Antioxidants** prevent free radical induced tissue damage by preventing the formation of radicals, scavenging them, or by promoting their decomposition.

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