

## FLAVONOIDS: A POWERFUL AND ABUNDANT SOURCE OF ANTIOXIDANTS

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Received: 11 Apr 2013, Revised and Accepted: 25 May 2013

### ABSTRACT

The aim of this review is to obtain the report regarding beneficial health effects of flavonoids. Flavonoids are phenol substance isolated from a wide range of vascular plants, with over 8000 individual compound known. Flavonoids are secondary plant products. They are mainly found in fruits, vegetables and certain beverages that have diverse beneficial biochemical antioxidant effect. Flavonoids were originally referred to as "vitamin P". Their dietary intake is quite high compared to other dietary antioxidants like vitamins C and E. The major actions of flavonoids are those against cardiovascular diseases, ulcers, viruses, inflammation, osteoporosis, diarrhea and arthritis. Brief description about the disease causing effect of free radicals is given and ways by which flavonoids neutralize free radicals has also been mentioned. The antioxidant activity of flavonoids depends on their molecular structure, and structural characteristics of certain flavonoids found in hops and beer confer surprisingly potent antioxidant activity exceeding that of red wine, tea, or soy. Flavonoids and proanthocyanidins are often found in fruits and vegetables and they powerful anticancer agents.

Antioxidants are the compounds that protects cell against the damaging effect of reactive oxygen species, such as singlet oxygen, superoxide, peroxy radicals and peroxy nitrite. They also can protect LDL stickier and more likely to clog arteries. They also act as an anti-aging.

**Keywords:** Flavonoids, Tea, Dietary sources, Flavonoid benefits, Quercetin, Epicatechin.

### INTRODUCTION

Earth is a planet which has various varieties of plant and their kingdoms. Green plants which various types of chemicals which is used in the various types of diseases. Humanity has identified as any as 7.5 lakhs species of plants on earth. There has always been a race between nature and human knowledge. The plants sustain the nature and nature sustain them. Flavonoids, also referred to as bio-flavonoids, are naturally occurring biological compounds that are often found in plants [1, 2, 3]. Quercetin, kaempferol, catechin and EGCG are examples of flavonoids. They are actually a type of antioxidant [4] that acts as a secondary metabolite. Flavonoids are secondary plant products that have previously been shown to be helpful in determining relationships among plant groups. Flavonoids are polyphenolic compounds that are ubiquitous in nature and are categorized, according to chemical structure, into flavonols, flavones, flavanones, isoflavones, catechins, anthocyanidins and chalcones [5, 6, 7, 8, 9].

The oxidation of low-density lipoprotein (LDL) has been recognized to play an important role in atherosclerosis. Immune system cells called macrophages recognize and engulf oxidized LDL, a process that leads to the formation of atherosclerotic plaques in the arterial wall. LDL oxidation can be induced by macrophages and can also be catalyzed by metal ions like copper. Several studies have shown that certain flavonoids can protect LDL from being oxidized by the above two mechanism [10, 11, 12, 13, 14, 15]

#### Dietary sources and natural supplements of flavonoids

Main sources of natural flavonoids are citrus fruits, berries, onions, parsley, legumes, green tea, and red wine. More specifically, anthocyanins are found in wine and bilberry, flavans are found in apples and tea, flavanones are found in citrus, and isoflavones are found in soya products. Average intake in the U.S. is approximately 150-200 mg per day.

#### Flavonoid benefits

There are many documented benefits associated with partaking in a diet that is rich in flavonoids. A few of the health benefits include:

- A reduced risk of cancer due to the powerful way they help the body build immunity and fight off unhealthy "scavengers" [13].
- Flavonoids have also been found to help fend off the onset of cardio-vascular diseases and may help prevent related consequences such as heart attack or stroke [20, 21].

© The anti-inflammatory properties of flavonoids also help the body fight off the worst affects of allergies. This is great news for millions of people who suffer every year from the ravages of hay fever [22].

- Flavonoids have also been found to inhibit the formation of blood clots, which also prevents the onset of heart attack and strokes [12, 16, 17, 23].
- Recent studies have also shown that flavonoids have properties which also prevent ulcers [11, 14, 24].

#### Flavonoids today

There are a wide variety of ways to take flavonoids today. Some of the most popular ways people take flavonoids at the most basic level is to alter what they eat and what they drink. Many people are switching to diets that are heavy in fruits, vegetables and nuts. They are supplementing this diet by enjoying the occasional piece of dark chocolate. As far as liquids are concerned, the biggest change people are making is to make sure they enjoy a cup of green tea every day [16, 17, 19, 25, 26].

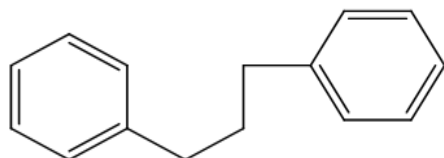
Antioxidants are compounds that protect cells against the damaging effects of reactive oxygen species, such as singlet oxygen, superoxide, peroxy radicals, hydroxyl radicals and peroxy nitrite. An imbalance between antioxidants and reactive oxygen species results in oxidative stress, leading to cellular damage. Oxidative stress has been linked to cancer, aging, atherosclerosis, ischemic injury, inflammation and neurodegenerative diseases (Parkinson's and Alzheimer's) [27]. Flavonoids may help provide protection against these diseases by contributing, along with antioxidant vitamins and enzymes, to the total antioxidant defense system of the human body. Epidemiological studies have shown that flavonoid intake is inversely related to mortality from coronary heart disease and to the incidence of heart attacks. Recent studies have demonstrated that flavonoids found in fruits and vegetables may also act as antioxidants [28, 29]. Like alpha-tocopherol (vitamin E), flavonoids contain chemical structural elements that may be responsible for their antioxidant activities. A recent study by Dr. van Acker and his colleagues in the Netherlands suggests that flavonoids can replace vitamin E as chain-breaking anti-oxidants in liver microsomal membranes. The contribution of flavonoids to the antioxidant defense system may be substantial considering that the total daily intake of flavonoids can range from 50 to 800 mg

Flavonoids, a group of naturally occurring benzo-g-pyrone derivatives, have been shown to possess several biological

properties (including hepatoprotective, anti-thrombotic, anti-inflammatory, and antiviral activities), many of which may be related, partially at least, to their antioxidant and free-radical-scavenging ability. The antiradical property of flavonoids is directed mostly toward HO $\cdot$  and O $_2$  $\cdot^-$  as well as peroxy and alkoxy radicals. Furthermore, as these compounds present a strong affinity for iron ions (which are known to catalyze many processes leading to the appearance of free radicals), their antiperoxidative activity could also be ascribed to a concomitant capability of chelating iron [22,30,31,32,33].

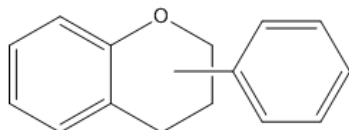
### Types of flavonoid

The flavonoids possessing 15 carbon atoms; two benzene rings joined by a linear 3-carbon atom

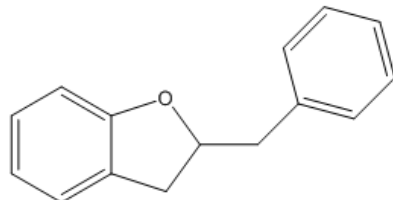


In the above skeleton have C-6 C-3 C-6 system.

The chemical structure of flavonoids are based on a C15 skeleton with a CHROMANE ring bearing a second aromatic ring B in position 2, 3 or 4.



In a few cases, the six-membered heterocyclic ring C occurs in an isomeric open form or is replaced by a five-membered ring.



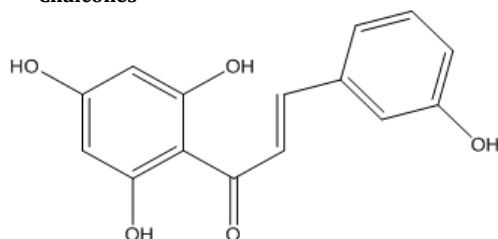
AURONES (2-benzyl-coumarone)

The oxygen bridge involving the central carbon atom (C2) of the 3C-chain occurs in a rather limited number of cases, where the resulting heterocyclic is of the FURAN type.

Various subgroups of flavonoids are classified according to the substitution patterns of ring C. Both the oxidation state of the heterocyclic ring and the position of ring B are important in the classification.

### Six major subgroups of flavonoids:[8, 34, 35]

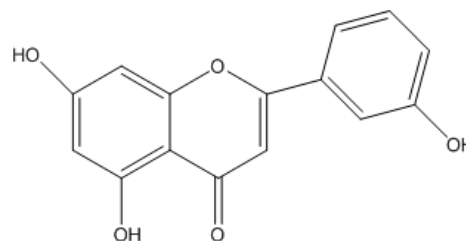
#### 1. Chalcones



#### 2. Flavone (generally in herbaceous families, e.g. Labiatae, Umbelliferae, Compositae).

Apigenin (Apiumgraveolens, Petroselinumcrispum).

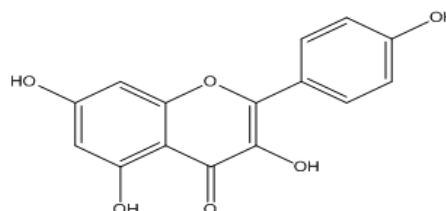
Luteolin (Equisetum arvense)



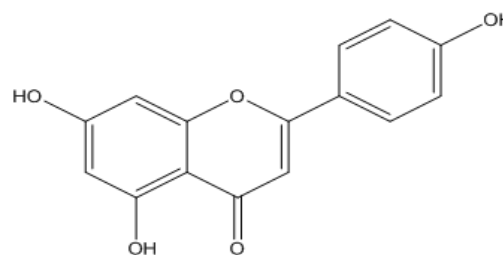
#### 3. Flavonol (generally in woody angiosperms)

Quercitol (Rutagraveolens, Fagopyrumesculentum, Sambucusnigra)

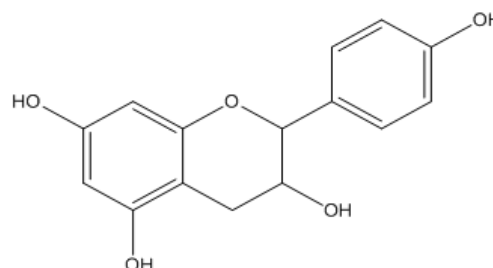
Kaempferol (Sambucusnigra, Cassia senna, Equisetum arvense, Lamium album, Polygonumbistorta).



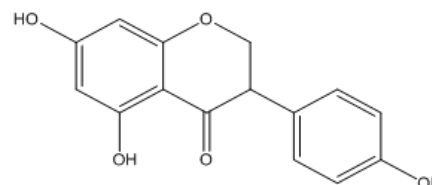
#### 4. Flavanone



#### 5. Anthocyanins



#### 6. Isoflavonoids



### Examples of flavonoids

#### Quercetin

Quercetin, a flavonoid and more specifically a flavonol, is the aglycone form of other flavonoid glycosides, such as rutin and quercitrin, found in citrus fruit, buckwheat and onions. Quercetin forms the glycosides, quercitrin and rutin, together with rhamnose and rutinose, respectively[15].

Although there is preliminary evidence that asthma, lung cancer and breast cancer are lower among people consuming higher dietary levels of quercetin, the U.S. Food and Drug Administration (FDA),

EFSA and the American Cancer Society have concluded that no physiological role exists. The American Cancer Society states that dietary quercetin is unlikely to cause any major problems or benefits [36,37,38].

### **Epicatechin (EC)**

Epicatechin may improve blood flow and has potential for cardiac health. Cocoa, the major ingredient of dark chocolate, contains relatively high amounts of epicatechin and has been found to have nearly twice the antioxidant content of red wine and up to three times that of green tea in vitro. In the test outlined above, it appears the potential antioxidant effects in vivo are minimal as the antioxidants are rapidly excreted from the body.

### **Tea (green and black) as rich source of flavonoids**

Almost all genuine tea originates from a plant: the evergreen *Camellia sinensis*. (Organic teas aren't regarded as real teas, but treated as beverages brewed from herbs, roots, along with other resources. Although some possess medicinal qualities, they're another class from traditional tea. About three kinds of tea are usually extracted from this solo shrub [39].

There are approximately 268 mg of flavonoids in a cup of brewed black tea, and also around 316 mg of flavonoids in a cup of green tea. A cup of brewed green tea offers over 5 times the flavonoids compared to red onion, another well-known flavonoid all-star. The best effective polyphenol in tea is a compound noted as epigallocatechingallate, or EGCG, that is associated with a team of flavonoid phytochemicals referred to as catechins. Studies have shown that in a test tube this catechins are better anti-oxidants compared to strong vitamins C and E. In a laboratory experiment, the EGCG in green tea was discovered to become 20 times stronger antioxidant compared to vitamin C.

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### **Structure-antioxidant activity relationships between flavonoids and phenolic acids**

The recent explosion of interest in the bioactivity of the flavonoids of higher plants is due, at least in part, to the potential health benefits of these polyphenolic components of major dietary constituents. This review article discusses the biological properties of the flavonoids and focuses on the relationship between their antioxidant activity, as hydrogen donating free radical scavengers, and their chemical structures. This culminates in a proposed hierarchy of antioxidant activity in the aqueous phase. The cumulative findings concerning structure-antioxidant activity relationships in the lipophilic phase derive from studies on fatty acids, liposomes, and low-density lipoproteins; the factors underlying the influence of the different classes of polyphenols in enhancing their resistance to oxidation are discussed and support the contention that the partition coefficients of the flavonoids as well as their rates of reaction with the relevant radicals define the antioxidant activities in the lipophilic phase [30].

### **Potential therapeutic uses**

Flavonoids have been called "biological response modifiers" due to their ability to modify the body's reactions to various stressors such as allergens, carcinogens and viruses. Hence they have been described as having anti-inflammatory, anti-allergic, anticarcinogenic, antioxidant, and antiviral properties. Flavonoids provide potent protection against oxidative and free radical damage [21, 39].

- General: Bruising, cardiovascular protection, menorrhagia (heavy menstruation), musculoskeletal injuries.

- Bilberry (*Vaccinium myrtillus*): Atherosclerosis, cataracts, diabetes, gingivitis (periodontal disease), macular degeneration, night blindness, retinopathy, varicose veins.

- Catechin: Hepatitis.

- Green tea Polyphenols: Antioxidant, cancer prevention and treatment.

- Hesperidin: capillary fragility, chronic venous insufficiency, menopause, seasonal allergies (hay fever).

- Proanthocyanidins: capillary fragility, diabetic retinopathy, macular degeneration, venous insufficiency, varicose veins.

- Quercetin: atherosclerosis, asthma, cancer, capillary fragility, cataracts, diabetes, edema, high cholesterol, peptic ulcer, rheumatoid arthritis, seasonal allergies (hay fever), SLE (lupus) [14,28].

- Rutin: capillary fragility, easy bruising, chronic venous insufficiency, edema, epistaxis (nose bleeds), glaucoma, musculoskeletal injuries, seasonal allergies (hay fever), varicose veins.

### **Deficiency symptoms [41, 42, 43, 44, 45, 462]**

Flavonoids have sometimes been designated as "semi-essential." Flavonoid deficiencies were first noted in the 1930's when Albert Szent-Gyorgyi discovered that a crude form of vitamin C which contained a flavonoid fraction worked better for treating bleeding gums than did a more refined form of vitamin C [31,33,39].

### **CONCLUSION**

The manuscript describes the identification of the quinone derived glutathione adducts of model compounds from two important classes of flavonoids as well as their formation in chemical incubations but also in a cellular system, reflecting pro-oxidant chemistry of antioxidant compounds, and pointing at an adverse reaction of supposed beneficial food ingredients.

Flavonoids have become more important since discoveries that concluded flavonoids have healthy benefits to humans, specifically antiviral, anti-allergic, antiplatelet, anti-inflammatory, anti-tumor and antioxidant activities.

Flavonoids protect against these and other diseases because they add to the overall antioxidant part of the immune system. There are over 4,000 identified flavonoids which are all characterized by their chemical structure. Depending on their structure, they could fall into one of these types: flavones, flavonols, flavanones, isoflavones, catechins, anthocyanidins and chalcones. A flavonoid antioxidant is found in plants like oranges, grape juice, apples, onions, tea and cocoa. While vitamins A, C and E are the most common antioxidants, Quercetin, Xanthohumol, isoxanthohumol, kaempferol, myricetin and genistein are the most common flavonoid antioxidants.

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