



Dietary Phenolic Compounds in Plants as Antioxidants

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ABSTRACT: *The antioxidant phenolic compounds that are found in plants are an essential part of human food. These compounds include a benzene ring having one or more hydroxyl groups and ascend from modest phenolic compounds to greatly link with long chained compounds. The oxidation inhibiting action of these compounds is based on the quantity and locus of hydroxyl groups. The main sources of phenolic compounds are fruits vegetable and beverages in human diet and the by product from food and agriculture have considerable amounts of phenolic which may be the main bases of antioxidants. These compounds are useful in treatment of many diseases including cancer, cardiovascular, microbial, viral and inflammatory diseases.*

Key words: *Antioxidants, Phenolics, plants, diseases, vegetables*

INTRODUCTION

Many phenolic compounds show anti-oxidant properties, this property depend upon the plant origin, growing conditions, harvesting time, storage condition and type of solvents used in the extraction (Martins et al., 2016). Both natural and synthetic anti-oxidants have property to produce free radical, which are effective to support the organisms as anti-oxidants however there is a prevalent agreement that artificial oxidation inhibiting compounds such as butylhydroxyanisole (BHA) and

butylhydroxytoluene (BHT) have health risk (Dudonne et al., 2009).

Phenolic compounds express both oxidation and reduction characteristics which are of great significance in adsorption and neutralization of free radicals. Oxygen is quenched and peroxides are decomposed (Zheng and Wang, 2001). Phenolic compounds are dietary constituent in many plants. Phenolic have wide range of compounds with different chemical structure due to their influence to color and astringency properties. Their analysis in food and beverages has been developed during last year (Monagas et al., 2005).

Table 1: Total Phenolic contents in selected materials (Fernandez-Panchon et al., 2008).

Products	Total phenolic content(mg/g)
Rosemary extract	2.19±0.15
Basil extract	147±160
Laurel extract	92.0±2.45
Cumin extract	37.4±0.32
Ginger extract(dw)	39.9±2.6
Extra virgin olive oil	0.27
High bush	2.78
Low bush	3.49
Cranberry	1.71
Strawberry	2.57±0.02
High bush blue berry	3.86±0.14
Low bush blue berry	4.71±0.19
Cherry	0.73
Wild mulberry	3.73±0.11
Black plum skin	92.5
Rough lettuce	0.53±0.09
Red cabbage	1.78±0.14
Wheat	1.86
Date	2.47
Rice kernel	1.85
Rice bran	16.4
Honey	0.35
Red wine	1.85±2.32
White wine	0.25±0.05
Green tea extract	59.8±1.8

The phenolic compound includes benzene ring with one or more hydroxyl groups and structure can be varied from modest phenolic compounds to greatly linked long chained compounds (Ignat et al., 2011).

Flavonoids

Flavonoids are the most plentiful in our usual food. Its structure comprising 15 carbon atoms organized in three rings (C6-C3-C6). There are additional six subgroups of flavonoids depending upon

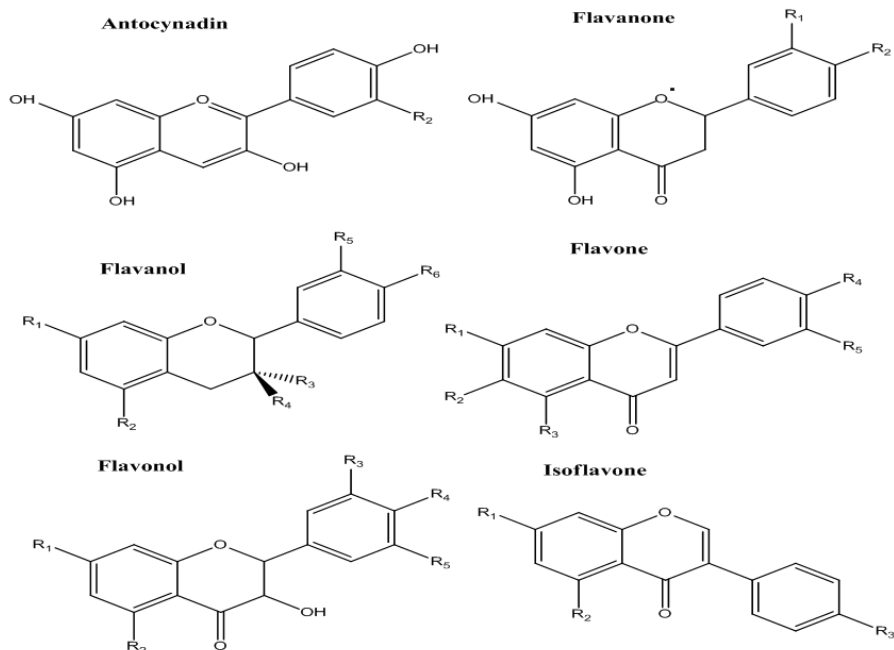


Fig. 1: Structures of flavonoids

CLASSIFICATION

Polyphenols are divided into Flavonoids, Tannins, stilbenes, lignans and Phenolic acids (Khanbabae et al., 2001; Manach et al., 2005; Archivio et al., 2007; Wojdyło et al., 2007; Dai and Mumper, 2010; Martins et al., 2011).

the oxidation state of central Carbon-ring, such as flavones, flavonols, flavanols, flavanones, is of flavones and anthocyanin.

Phenolic acid

There are additional two classes of phenolic acids that are derivatives of benzoic acid and cinnamic acid. Benzoic acid includes gallic acid and cinnamic acid includes ferulic acid respectively.

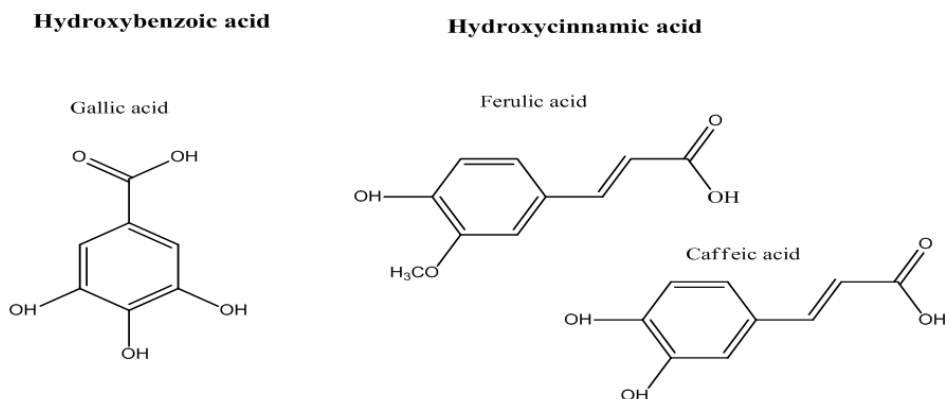


Fig. 2: Structures of phenolic acid (Biljana et al., 20)

Tannins

Tannins are major polyphenols in our usual food and distributed into two subgroups i.e. condensed tannins and hydrolysable tannins.

Hydrolysable tannins

They carry glucose in the center and another polyol ester that is gallic acid; it is named as gallotannins or ellagitannins with hexahydroxydiphenic acid.

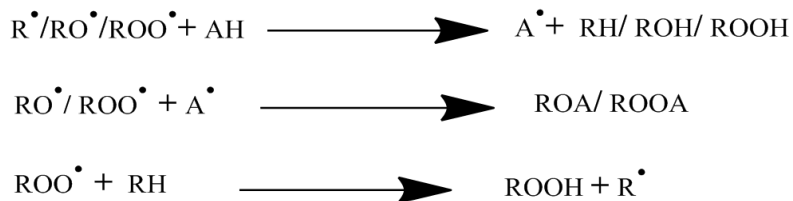
Condensed tannins

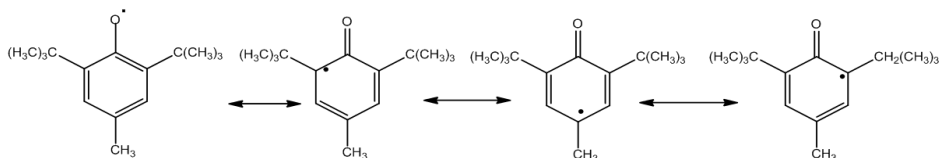
They are complex long chains of flavan-3-ol linked from side to side to an

interflavan carbon bond, they are denoted as proanthocyanidins.

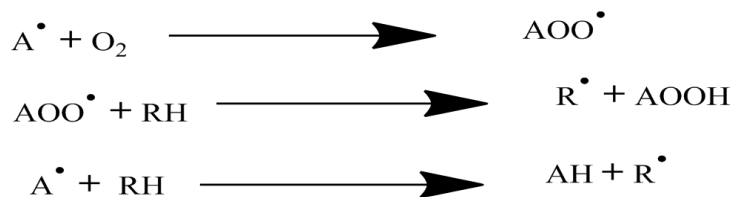
Mechanism of action of Phenolic antioxidants

The oxidation inhibiting characteristics of phenolics depend upon the quantity and arrangement of OH group. Phenolic anti-oxidant can give hydrogen atom to lipid radical to yield derivatives of lipid and oxidation inhibiting radicals. The anti-oxidant free radicals may interfere further with the chain propagation reaction (Sherwin, 1978; Nawar et al., 1985; Belitz et al., 1986; Shahidi et al., 1992).





The anti-oxidant free radical can undergo redox reaction in the presence of oxygen and any alkyl group. Such as;



The phenoxyl radical become stable due to delocalization of unpaired electrons around the benzene ring, which take part in termination reaction. Anti-oxidant property is enhanced by substitution reaction at Para position with n-butyl group instead of methyl group. However long, and branched chain reduces the anti-oxidant property. The resonance structures of phenoxyl radical are (Shahidi and Ambigaipalan, 2015).

Sources

Almost all plants, vegetables, fruits and beverages such as juices, tea and wine are considered as chief sources of phenolic compounds in the human usual food (Spanos et al., 1990; Bravo, 1998; Shrikhande, 2000; Balasundram et al., 2006).

Fruits and vegetables

The overall phenolic collection of many vegetables or fruits carries great variation. The phenolic content holds

variation because of the complex nature of these phenolic compounds and the process of analysis and extraction. Table 2 showed the phenolic content of some fruits like apple, banana, cherry, guava and mango and vegetables like broccoli, carrot, cucumber, mint and spinach etc.

Beverages

The chief sources of phenolics in the human usual food beverages are Juices of fruits, wine and tea. The composition and content of phenolics vary in juices depend upon commercial processing procedures. In the same way phenolic composition vary in wines and examined through a number of aspects for instance kinds of grapes utilized, developing circumstances, procedure parameters and wine manufacturing procedures.

Table 2: Phenolic content in some fruits, vegetables, fruit juices and beverages.

Sources	Total Phenolic content
Fruit: Apple	296.3±6.4
Banana	90.4±3.2
Blueberry	270-930
Cherry	105.4±27.5
Guava	126.4±6.0
Litchi	3.35±0.05
Mango	6.25±0.05
Strawberry	160±1.2
Vegetables: Broccoli	101.6±1.24
Brssel sprouts	68.8±1.3
Cabbage	54.6±7.0
Carrot	56.4±5.1
Mint	399.8±3.2
Spinach	91.0±8.5
Tomato	25.9-50.0
Yellow onion	76.3±1.9
Commercial fruit juices:Apple	339±8.5
Grape fruit	535±11
Orange	755±18
Pineapple	358±3
Prune	441±59
Beverages:	
Black tea	80.5-134.9
Green tea	117.3
Instant coffee	146-151
Ground coffee	52.5-57.0
Red wines: Argentine	1593-1637
French	1847-2600
Italian	3314-4177
Japanese	1810-2151
Spanish	1869
White wines: Argentine	216
Italian	439-854
Japanese	295-556
Spanish	292
Rose wines: Italian	1304
Japanese	340

Agro-industrial by-products

Phenolics have been found in many by-products of agriculture, for instance buck wheat and rice hulls. Hulls of Pistachio are also a source of phenolic anti-oxidant. It may comprise 34mg tannic acid. The peels of different fruits and vegetables have been found to contain greater amount of anti-oxidant phenolics than the edible fleshy part. By-products and waste of olive industry are the chief phenolic compounds. Grape seed, grape juices and white wine manufacturing side products are the bases of phenolic compounds.

Health potentials of phenolic compounds

The eating behaviors and inclinations of individuals significantly have impact on the dietary consumption of phenolics. The normal ingestion of food polyphenols is about 1 gram per individual. The chief sources are vegetables, fruits and beverages. Phenolics show its activities as in vitro anti-oxidant and are effective against many diseases like cancer, cardiovascular diseases (Velderrain-Rodríguez et al., 2014). It was identified that eating of caffeine, black tea extract and orange peel extract through mouth had positive effects against obesity. It was also identified that four fruits for instance blueberry, apple, orange and grapes collectively provide an interactive impact on oxygen inhibiting activity (Shahidi et al., 2015).

The chief constituent of the orange peel is polymethoxy flavones. It acts as anti-thrombogenic, anti-pathogenic

anti-inflammatory, anti-carcinogenic, anti-oxidant and anti-viral. The hydroxytyrosol is a chief phenolic component of olive oil that decreases the atherosclerosis and coronary heart disease by itself. Soy contains isoflavones which are effective against chronic diseases including different kind of cancer, abnormal loss of bony tissue, cardiovascular diseases and menstrual symptoms. Isoflavones are also effective to reduce allergic rhinitis (Balasundram et al., 2006, Dimitrios, 2006; Pourmorad et al., 2006). Some plants have health benefits such as phenolic compounds of peanuts, pistachio, grapes and berry fruits.

Reverol has shown cardio-protective impacts also helpful in dropping the weight of body at advanced dosages. It may decrease overweight mass by preventing adipogenesis and enhancing cell deaths in adipocytes through disturbing of genes that control the functions of mitochondria (Scalbert et al., 2005).

CONCLUSION

Phenolic compounds are abundantly found in plants, and when plants are utilized, these compounds help the human body in combating diseases and render the natural anti-oxidant to the human usual food. These compounds contain a benzene ring with hydroxyl groups at different positions which determine the anti-oxidant activity of the phenolic compounds having different structures. Fruits, vegetables, beverages and by-product from agriculture are the

main bases for these compounds. The health benefits are generally ascribed to their pleiotropic biochains such as anti-inflammation, anti-infection, anti-cancer and anti-proliferation.

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