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### Tannins are Astringent

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Tannins are obtained upon the decomposition of vegetation. They will generally be found in surface water supplies or shallow wells. Although these compounds are not a health risk, they are aesthetically displeasing. Tannins are difficult to remove from water. Tannins can cause a yellow to brown cast in water and may also affect a taste and odour.

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*Keyword:* Tannins, Astringent, Phenol, Tea, Wine

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#### 1. Introduction

"Any phenolic compound of sufficiently high molecular weight containing sufficient hydroxyls and other suitable groups (i.e. carboxyls) to form effectively strong complexes with protein and other macromolecules under the particular environmental conditions being studied".

Tannins are astringent, bitter plant polyphenols that either bind and precipitate or shrink proteins. The astringency from the tannins is that which causes the dry and puckery feeling in the mouth following the consumption of red wine, strong tea, or an unripened fruit<sup>[1]</sup>. The term tannin refers to the use of tannins in tanning animal hides into leather; however, the term is widely applied to any large polyphenolic compound containing sufficient hydroxyls and other suitable groups (such as carboxyls) to form strong complexes with proteins and other macromolecules. Tannins have molecular weights ranging from 500 to over 3000<sup>[2]</sup>. Tannins are found as shapeless yellowish or light brown

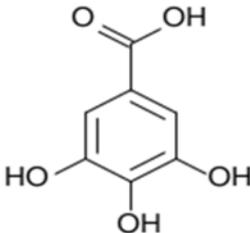
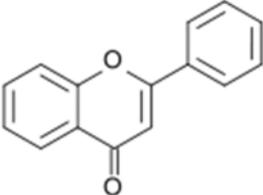
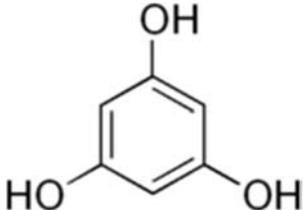
masses like powder, flakes or sponge. Interestingly, tannins are found almost in all plants and in all climates all over the world. The name 'tannin' is derived from the French word 'tanin' (tanning substance) and is used for a range of natural polyphenols. Lower plants such as algae, fungi and mosses do not contain much tannin. The percentage of tannins present in the plants, however, varies. While they are present in significant proportions in some plants, many others have too little of them. Tannins are usually found in large quantities in the bark of trees where they act as a barrier for micro-organisms and protect the tree. Apart from tanning, tannins are also used in dyeing, photography, refining beer and wine as well as an astringent in medicines. Significantly, tannins form a vital element of tea <sup>[3]</sup>.

While soluble, astringent materials are found in some plants like tea and coffee, tannins are supplemented to various processed foods, including ice-cream and caramel. They are also

used as refining materials to precipitate proteins in wines and beer. As tannins often lower the absorption of some materials into the body, tannins are also often known as anti-nutrients. For example, tannins are found in tea and coffee and consuming too much of these beverages without milk may lead to calcium and iron deficiency in the body and often lead to osteoporosis and anemia<sup>[4]</sup>.

In order to counter these problems, it is advised that one should take tea or coffee between meals and not consecutively. In addition, adding milk or lemon juice to the tea helps in reducing or neutralizing tannins' adverse actions on iron intake. Similarly, consuming food that is rich in vitamin C also helps in neutralizing tannin's effects on iron absorption<sup>[5]</sup>.

**Table1:** Tannins can be classified into three broad groups – hydrolysable tannins, condensed tannins and Pseudotannins.

<b>Base Unit:</b>	 Gallic Acid	 Flavone	 Phloroglucinol
<b>Class/Polymer:</b>	Hydrolyzable Tannins	Condensed Tannins	Phlorotannins
<b>Sources</b>	Plants	Plants	Brown algae

The apple contains several phenolic substances, i.e., chlorogenic acid, catechin, epicatechin, phlorizin, rutin, flavonoids, and condensed tannins. The apple condensed tannins (ACT) are contained in unripe apples at a ten times higher level than in the ripe ones<sup>[6]</sup>. Condensed tannins are called proanthocyanidins, and have a wide distribution in plants as secondary metabolites. We consume small amounts of these compounds in daily life from fresh fruits such as apple and the processed foods made from these fruits. Rather than nutrients, plant proanthocyanidins are known as the functional food factors that possess a variety of physiological activities including antioxidant<sup>[7-9]</sup>.

### 1.2 Occurrence

Tannins are distributed all over the plant kingdom. Tannins are formed upon the decomposition of vegetation. These compounds are large molecular weight organics that fall under two large primary categories: Humic acids and Fulvic acids. These are simplified structures, but they show the complexity of tannins. Gallic Acid, Guaiacyl, Syringyl and Cresylic Moieties are the building blocks of these large organic molecules<sup>[10]</sup>. The structure of the tannin varies, depending on the plant life in a given area. Tannins are found in leaf tissues, bud tissues, seed tissues, root tissues and stem tissues. An example of the location of the tannins in the stem tissue is that they are often found in the growth areas of trees, such as the secondary phloem and xylem and the layer between the cortex and epidermis. Tannins may help regulate the growth

of these tissues. They are also found in the heartwood of conifers and may play a role in inhibiting microbial activity, thus resulting in the natural durability of the wood<sup>[11]</sup>. Tannins can cause a yellow to brown cast in water and may also impart a taste and odor. They will generally be found in surface water supplies or shallow wells. Although these compounds are not a health risk, they are aesthetically displeasing. It present, tannins are difficult to remove from water. Tannins can be removed by various methods. One treatment method may be effective in one area, but may be very ineffective 10 miles down the road. It is all dependent on the vegetation in a given area. Styrene based macroporous anion resin has long been used to remove tannins from water. This type of resin has worked well in some areas but poorly in others. More recently, acrylic based resins have emerged on the market and are producing better results when removing tannins from water. The acrylics can also be manufactured with a macroporous structure. The additional porosity enables the tannins to be regenerated from the resin more effectively<sup>[12]</sup>.

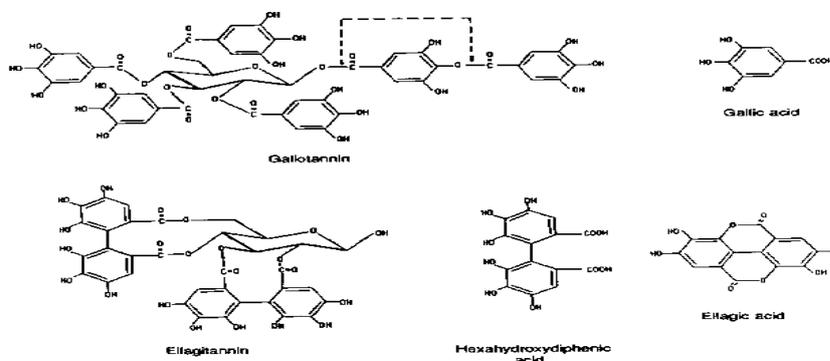
Location of the tannins in various plant tissues:

- Bud tissues - most common in the outer part of the bud, probably as protection against freezing
- Leaf tissues - most common in the upper epidermis. However, in evergreen plants, tannins are evenly distributed in all leaf tissues. They serve to reduce palatability and, thus, protect against predators.

- Root tissues - most common in the hypodermis (just below the epidermis). They probably act as a chemical barrier to penetration and colonization of roots by plant pathogens.
- Seed tissues - located mainly in a layer between the outer integument and the aleuronic layer. They have been associated with the maintenance of plant dormancy, and have allopathic and bactericidal properties.
- Stem tissues - often found in the active growth areas of the trees, such as the secondary phloem and xylem and the layer between epidermis and cortex. Tannins may have a role in the growth regulation of these tissues. They are also found in the heartwood of conifers and may be contribute to the natural durability of wood by inhibiting microbial activity<sup>[13]</sup>.

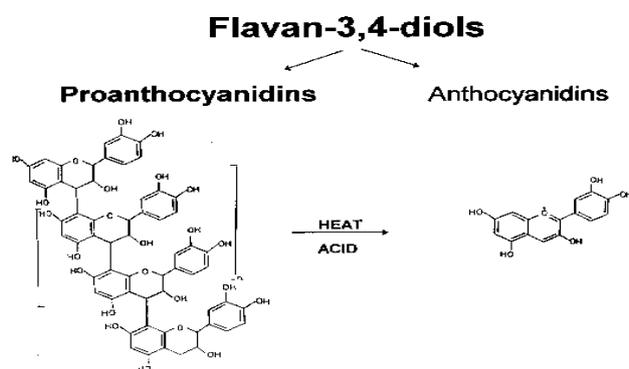
### 1.3 Hydrolyzable Tannins:

At the center of a hydrolyzable tannin molecule, there is a carbohydrate (usually D-glucose). The hydroxyl groups of the carbohydrate are partially or totally esterified with phenolic groups such as gallic acid (in gallotannins) or ellagic acid (in ellagitannins). Hydrolyzable tannins are hydrolyzed by weak acids or weak bases to produce carbohydrate and phenolic acids. Examples of gallotannins are the gallic acid esters of glucose in tannic acid (C<sub>76</sub>H<sub>52</sub>O<sub>46</sub>), found in the leaves and bark of many plant species.



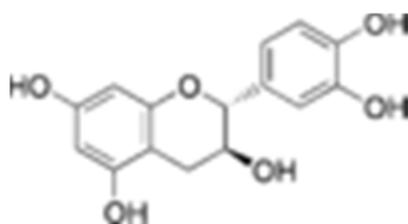
### 1.4 Condensed Tannins

Condensed tannins, also known as proanthocyanidins, are polymers of 2 to 50 (or more) flavonoid units that are joined by carbon-carbon bonds, which are not susceptible to being cleaved by hydrolysis. While hydrolyzable tannins and most condensed tannins are water soluble but few very large condensed types of tannin are insoluble<sup>[14]</sup>.



### 1.5 Pseudotannins:

This is not such a different group of tannins, but may be treated as sub group because they do not obey to Goldbeaters skin test and is low molecular weight compounds. Chlorogenic acid in coffee and nux vomica, ipecacuanha acid in ipecacuanha and catechins in cocoa are examples of pseudotannins. The detection test for chlorogenic acid is carried out by extracting the drug with water and treating this extract with ammonia solution, followed by exposure to air, which leads slowly to formation of green color.



Catechin

### 1.6 Foods with tannins:

**1.6.1 Tea:** The tea plant (*Camellia sinensis*) is an example of a plant said to have naturally high tannin content. When any type of tea leaf is steeped in hot water it brews a "tart" (astringent) flavor that is characteristic of tannins. This is due to the catechins and other flavonoids. Tea "tannins" are chemically distinct from other types of plant tannins such as tannic acid<sup>[13]</sup> and tea extracts have been reported to contain no tannic acid<sup>[14]</sup>. Black tea and peppermint tea are inhibitor of iron than herb teas like chamomile, vercaïn, lime flower and pennyroyal<sup>[15]</sup>.

**1.6.2 Wine:** Tannins (mainly condensed tannins) are also found in wine, particularly red wine. Tannins in wine can come from many sources and the tactile properties differ depending on the source. Wine tannins come from grape skins, stems and seeds, and their extraction is heavily dependent on the particular winemaking process involved. Some tannin also comes from barrels, particularly new ones, where these are used to age wine. The complicating factor here is that the chemical make-up of the tannins is actually changed during the winemaking process. Not only does the chain length change, but the different chemical entities that stick to the sticky bits of the phenolic subunits also changes. Recently, a study in wine production and consumption has shown that tannins in the form of proanthocyanidins have a beneficial effect on vascular health. The study showed that tannins suppressed production of the peptide responsible for hardening arteries. To support their findings, the study also points out that wines from the regions of southwest France and Sardinia are particularly rich in proanthocyanidins, and that these regions also produce populations with longer life spans<sup>[16]</sup>.

**1.6.2 Beer:** High amounts of tannins are in the hopes of some beers. The amount of tannins in beer depends on quality of yeast

along with other factors. The more bitter, the more tannins, less bitter, the less tannins.

**1.6.3 Nutrition:** Tannins are phenolic compounds that interfere with iron absorption through a complex formation with iron when it is in the gastro-intestinal lumen which decreases the bioavailability of iron. There is an importance difference between the way in which the phenolic compound interact different hydroxylation patterns (gallic acid, catechin, chlorogenic acid) and the effect on iron absorption. The content of the iron-binding galloyl groups may be the major determinant of the inhibitory effect of phenolic compounds<sup>[17]</sup>.

**1.7 Uses:** Tannins may be employed medicinally in antidiarrheal, haemostatic, and antihemorrhoidal compounds. The anti-inflammatory effects of tannins help control all indications of gastritis, esophagitis, enteritis, and irritating bowel disorders. Diarrhea is also treated with an effective astringent medicine that does not stop the flow of the disturbing substance in the stomach; rather, it controls the irritation in the small intestine<sup>[18]</sup>. Tannins not only heal burns and stop bleeding, but they also stop infection while they continue to heal the wound internally. The ability of tannins to form a protective layer over the exposed tissue keeps the wound from being infected even more. Tannins are also beneficial when applied to the mucosal lining of the mouth<sup>[19]</sup>. Tannins can also be effective in protecting the kidneys. Tannins have been used for immediate relief of sore throats, diarrhea, dysentery, hemorrhaging, fatigue, skin ulcers. Tannins can cause regression of tumors that are already present in tissue, but if used excessively over time, they can cause tumors in healthy tissue. They have been also reported to have anti-viral<sup>[20]</sup> antibacterial<sup>[21-22]</sup> and antiparasitic effects<sup>[23]</sup>. When incubated with red grape juice and red wines with a high content of condensed tannins, the

poliovirus, herpes simplex virus, and various enteric viruses are inactivated<sup>[24]</sup>.

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