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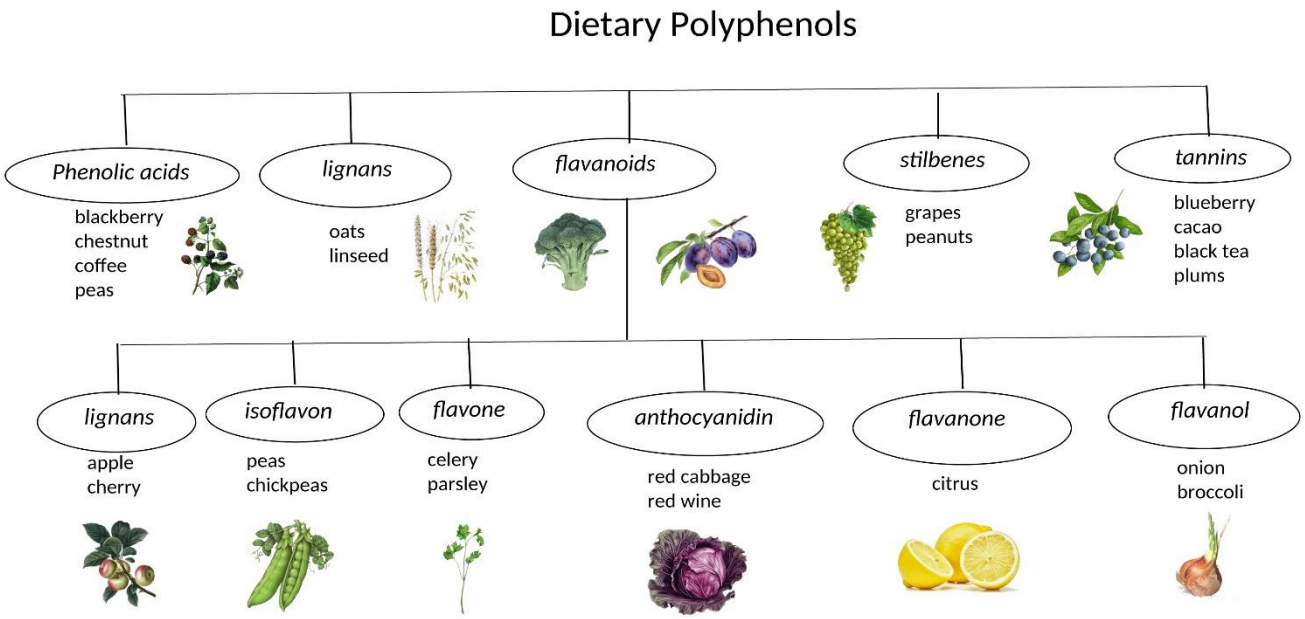
Polyphenols - powerful plant compounds

Plants are packed full of compounds named phytonutrients, also known as phytochemicals. Essentially they are the plant's immune system, providing protection against viruses, bacteria, insects, oxidation and background radiation. These compounds create the colour and aroma of plants which attracts pollinators.

Fruit, vegetables, cereals, legumes and seeds all have an array of phytonutrients which can exert a positive effect on our health. Phytonutrients have anti-oxidant capacities which help prevent damage to cells from highly reactive, unstable molecules known as free radicals. Various phytonutrients have been linked to preventative and/or therapeutic effects for age-related physical and mental decline, cardiovascular disease, cancer, type 2 diabetes and obesity. ①②③

More than 10,000 phytonutrients have been identified ④ and they are categorised depending on their chemical structure. Polyphenols are the largest and the most widely distributed category amongst edible plants. Polyphenols are subdivided into five categories based on the number of phenol rings they contain and the structural elements that bind these rings to one another. They are phenolic acids, stilbenes, lignans, tannins and flavonoids.



Phenolic acids

Phenolic acids can be divided into two main categories. Derivatives of benzoic acid such as gallic and ellagic acid and derivatives of cinnamic acid including caffeic acid and ferulic acid. Gallic acid is found in a variety of common foods and drinks including blueberries, grapes and green tea. Good sources of ellagic acid include raspberries, blackberries and walnuts. Caffeic acid is found in blueberries, plums, apples and coffee. Ferulic acid is found in the outer layers of cereal grains. Studies show that phenolic acids have a range of benefits including treating depression, cancer & CVD. ⑤

Stilbenes

Generally, stilbenes are only found in small quantities in our diets. The most studied stilbene is resveratrol found in grapes, wine, peanuts & cranberries. Different studies have suggested that resveratrol is effective in the prevention of a variety of diseases including CVD, prostate cancer & Alzheimer's. ⑥⑦⑧

Lignans

These are found in whole grains, nuts, and seeds. Linseed has the highest concentration of any food. Studies have shown that lignans reduce the risk of cardiovascular disease. They are also a type of phytoestrogen which effects estrogen metabolism. Some clinical trials have shown that linseed can have an important role in decreasing breast cancer risk, mainly in postmenopausal women. ⑨⑩

Tannins

Tannins are found in almost all plant foods and some beverages. They are responsible for the astringent taste. Tannins are often thought of as 'antinutrients' because of their ability to interfere with the absorption of nutrients. However, research has shown that tannins have many benefits including reducing the risk of cancer and neurodegenerative diseases. ⑪

The most abundant types of tannin are proanthocyanidins and the best sources are found in chokeberry, black currant, quince, pomegranate rosehips, walnut, peanut and cacao. Studies have shown that proanthocyanins help to protect the body from sun damage, improve vision, improve flexibility in joints, and strengthen capillaries. ⑫

Flavonoids

Flavonoids are one of the largest categories of polyphenols with more than 5000 identified. They are found in colourful fruits, vegetables, tea, and wine. Based on their chemistry they are further divided into 6 subclasses, flavonols, flavones, flavanones, flavanols, anthocyanins and isoflavones.

Flavonoids possess several medicinal benefits, including anticancer, antioxidant, anti-inflammatory, and antiviral properties. They also have neuro-protective and cardio-protective effects depending on the type of flavonoid. ⑬

Phytonutrients, unlike protein, carbohydrates, fats, vitamins and minerals are not considered nutritionally essential for life. Nevertheless, given the major challenge of non-communicable diseases including CVD, cancer, type 2 diabetes and obesity superabundant polyphenols can play a really important role in human health and disease.

The various health benefits of dietary polyphenols are determined not only by their concentration but also their bioavailability. Bioavailability involves the fraction of polyphenols released from the food matrix. It is also determined by an individuals ability to digest and absorb and the capacity of the polyphenols to act on target cells or tissues.

Multiple environmental factors - soil type, sunshine, rain & toxins will influence the biosynthesis and accumulation of polyphenols in plants. Agricultural practices - organic, hydroponic, greenhouse and chemical growing all affect polyphenol content as do different cultivars of the same species. Industrial processing techniques and domestic kitchen preparations influence the final polyphenol content in the food and its bioavailability.⑭

Agro-ecological farming practices do not use chemicals which can harm beneficial micro-organisms in the gut. ⑮ Natural systems are used to create healthy soils and plants. The pesticide glyphosate shuts down the shikimate pathway which produces many phytonutrients. ⑯

Once harvested storage conditions can affect polyphenol content of plants leading to chemical/structural changes. Lower temperatures of around 4C keep polyphenols stable for longer.

A key factor that affects the stability of polyphenols in fruits and vegetables is the pH. Generally, polyphenols are more stable at a lower pH which is why polyphenol-rich fermented foods are reported to have better bioavailability and bioactivity than foods that are just polyphenol rich. ⑰

Polyphenols are influenced to a variable extent by different methods of cooking such as blanching, boiling, steaming, frying and grilling. The loss of polyphenols during cooking depends on the individual polyphenol. Studies ⑱ have shown that in many cases boiling is the most detrimental mainly due to extensive leaching. Light steaming and gentle pan frying appear to preserve higher amounts of polyphenols.

Polyphenols are generally consumed together with macronutrients, micronutrients, and other components. The type of food matrix plays an important role in the bioavailability of polyphenols. Dietary fibre and protein-rich meals can have a detrimental effect on polyphenol bioaccessibility whereas digestible carbohydrates and dietary lipids can enhance polyphenol uptake. ⑲⑳

Only around 5% - 10% of polyphenols are absorbed in the small intestine. The rest reach the colon without any change. Here they are metabolized by the enzymatic action of the gut microbiota. After absorption by epithelial cells, colonic metabolites reach the liver via the portal vein. Here they undergo various processes which determine their biological activity on target cells and tissues.

The presence of polyphenols in the colon helps cultivate a healthy microbiota by inhibiting the growth of pathogenic bacteria and stimulating the growth and development of beneficial bacteria. Polyphenols have a positive impact on maintaining the structure and function of the gut wall, specifically the intestinal mucosa – the membrane that lines the inside of the gut. Having a healthy gut mucosa is vital to efficiently absorb nutrients and support the cells of the immune system.

There is a consensus that polyphenols provide considerable health benefits. Although there has been an increase in isolated polyphenol supplements these do not appear to offer the same benefits as polyphenol-rich foods. This is most likely because synergistic interactions with other compounds

naturally found in whole foods have been eliminated. ㉑ To help ensure maximum polyphenol intake and utilisation there are a few basic guidelines.

- Choose fruit and vegetables **grown naturally** without the use of chemicals.
- Eat a **wide variety** of seasonal fruits & vegetables.
- Colour your plate with **rainbow foods.**
- Eat **wholegrains**
- **Minimise sugar.**
- Prepare food using a **variety of techniques and cooking methods.**
- To make the most of seasonal produce learn to **preserve.**
- Eat **fermented vegetables** regularly.
- **Maintain quality** by storing fruit and vegetables the right way.

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