

Effect of Plant Products Polyphenols on Human Health

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ABSTRACT

Polyphenols are one group of plant products that have antioxidants and anti-inflammatory properties, and by which they can protect human health from many diseases. Some of the sources of polyphenols are Apples, Berries, Cocoa, Nuts, Tea, Onions, and Seeds. These Polyphenols since can cross the Blood-Brain Barrier (BBB) are effective to prevent the neurons from damages from inflammation and oxidative stress in the brain. Aggregation and deposition of amyloid-*b*-protein (*Ab*) and *tau* protein in the brain can cause the onset of Alzheimer's disease. Similarly, deposition of coagulated synuclein-protein in the neuron causes the Parkinson's disease to develop. These phytochemicals can modulate the expression of various gene(s), and act as antioxidants as well as anti-inflammatory agents and protects from the neural damages along with the other kind of diseases like ischemic heart disease. However, there is a lack of enough clinical trials with the food constituents and also yet unknown their mechanism of action against the diseases.

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Abbreviations

SGLTs: Sodium–Glucose Transporters

LDL: Low-Density Lipoprotein

HDL: High-Density Lipoprotein

HbA1c: Hemoglobin A1C

CRP: C-Reactive Protein

NCDs: Non-Communicable Disease

PUD: Peptic Ulcer Disease

IBD: Inflammatory Bowel Disease

FMD: Fibro Muscular Dysplasia

NO: Nitric Oxide

Introduction

Various plant products, like fruits, leaves, stems, roots, and seeds that are edible contain polyphenols. To name, Apples, Berries, Cocoa, Nuts, Tea, Onions, and Seeds are some of them, which contain substantial amounts of polyphenols. These phytochemicals can scavenge the superoxide toxicity in the body and reduce the risk of having cancer, diabetes, heart disease, and also the neurodegenerative diseases (NDD) [1,2].

The polyphenols include the flavonoids, stilbenes, phenolic acids, and lignans, which are composed of a large group of bioactive phytochemicals [3,4]. Apples, onions, dark chocolates, and red cabbage are rich in flavan-3-ols, flavanols, flavones, isoflavones, flavanones, and anthocyanins, and these polyphenols and their metabolites stay in the colon for longer periods of time, and therefore may exert a positive impact on the resident microbiome

[5,6]. Stilbenes group phytochemical are non-flavonoid but carry polyphenolic structure [7]. Resveratrol is one of the compounds from stilbene group is found in grapes and berries [8]. These compounds can inhibit the cytokine release and NO synthesis, resulting in anti-inflammatory and antioxidant actions, respectively [8]. A relevant mechanism of action for resveratrol is the activation of sirtuin, a signaling protein, involved in the metabolic regulation and delay of aging [9]. Two different meta-analysis of randomized controlled trials showed contradictory results of resveratrol effect on the fasting glucose level, total cholesterol, C-reactive protein (CRP), and systolic/diastolic blood pressure [7,10].

The other member of the polyphenol group is flavanols. A randomized, controlled trial showed that consumption of flavonoid-rich apple increases the quercetin concentrations in plasma and significantly improved the Endothelin 1 (ET-1) function in them [11,12]. Another controlled study with subjects reported with cardiovascular disease, showed that quercetin administration significantly can reduce the LDL cholesterol level and also the systolic pressure in blood of those individuals [13]. Those observations were further proved by a meta-analysis of randomized, controlled trials conducted with quercetin supplements [9,14,15].

Functions

Anti-Microbial Effect

Green tea as well as black tea contains some polyphenols, which can inhibit the growth of some harmful bacteria like *Escherichia coli*, *Helicobacter pylori*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, HIV, influenza as well as hepatitis C and *Candida* [15-19].

Lower Blood Sugar Levels

Polyphenols prevent the breakdown of starch into simple sugars and thus help to lower the blood sugar levels and the risk of type 2 diabetes [20,21]. These compounds also can stimulate the insulin secretion, which decreases the blood glucose level by transporting them to cells for metabolism [22,23]. Among polyphenols, anthocyanins offer the most potent anti-diabetic effect as per the research suggests [24,25]. Anthocyanin typically found in red, purple, and blue-colored fruits, such as berries, currants, and grapes [26].

Phlorizin is another active, found in apples and that can be absorbed in the small intestine and potentially be transported by sodium–glucose transporters (SGLTs) [27,28]. This Phlorizin can inhibit SGLT-1 and SGLT-2 and therefore can be used against hyperglycemia [29,30].

Lower Risk of Heart Disease

Since polyphenols contain good amounts of antioxidants, this can help to inhibit the chronic inflammation, and thus can lower the risk for heart disease. Besides all the above, polyphenols are good to interact with the gut microbiome. Two recent reviews link the polyphenol functions in lowering blood pressure as well as the ratios of LDL (bad) vs. HDL (good) cholesterol in the blood [31,32]. However, in reality these conditional effects may not be relevant as the concentration of the effectives could be very small, in vivo [28,33].

Another review indicates that higher intake of lignan, a type of polyphenol found in flaxseeds and whole grains, increases the enterolactone level in the body which actually lowers the risk of heart diseases by 40-45% [34,35]. A few commonly consumed foods like tea, nuts, cocoa (chocolate), grapes (wine), and legumes, are high in flavan-3-ols [36,37].

Flavonoids/Flavanols belongs to a specific class of polyphenolic compounds, that are used to make various kinds of plant-based foods, and beverages [38,39]. Intake of those compounds (400–600 mg/day) can improve blood pressure, cholesterol level, and blood sugar, as reported [40-43]. Cocoa (chocolate), has also been associated with a reduced arterial stiffness, and thus inhibits systolic hypertension [42]. Some meta-analyses have reported that flavan-3-ols containing foods can reduce the risk for stroke and myocardial infarction [44,45]. However, another meta-analysis found no such significant effect on total, LDL, or HDL cholesterol level [46].

Anthocyanins, another kind of flavonoids, presents in red and blue fruits like, blueberries, raspberries, red grapes, cherries, and some vegetables, can be used as anti-inflammatory metabolites by microbiome [47]. Two meta-analyses of randomized trials revealed that consumption of anthocyanins-containing fruits (e.g. juices, whole berries, extracts) significantly reduces the level of LDL cholesterol, systolic blood pressure, HbA1c [45,48].

Prevent Blood Clots

Platelet aggregation which is known as blood clots, prevent excessive bleeding but its negative side is the cause of deep vein thrombosis, stroke, and pulmonary embolism, etc. [49]. Polyphenols, as per the laboratory as well as animal studies were found to reduce the platelet aggregation process, thereby may prevent the formation of blood clots in the body [50-52].

May Protect Against Cancer

Research consistently suggests that diets rich in plant foods lower the risk of cancer, and polyphenols are considered as a key factor due to their strong antioxidant and anti-inflammatory properties [53-56]. Some laboratory studies showed that polyphenols are growth inhibitory of various cancer cells [57,58]. In humans, some studies find a link between polyphenol intake with a lower risk of breast and prostate cancer, while others find no such effects [59].

Polyphenols May Promote Healthy Digestion

Polyphenols, being friendly to the gut bacteria, help food digestion by the human being [57,60]. Evidences are there that polyphenol-rich tea extracts promote the growth of beneficial microbes, bifidobacteria [61]. However, green tea polyphenols inhibit the growth of harmful bacteria, like *C. difficile*, *E. Coli*, and *Salmonella*, and thus improve the symptoms of peptic ulcer and inflammatory bowel disease (IBD) [62,63]. In addition, polyphenols may help probiotics thrive and survive. However, more research is needed [64].

Polyphenols May Promote Brain Function

Polyphenol-rich foods may increase the memory and cognitive functions. One study report that drinking grape juice, which is rich in polyphenols, helped significantly to boost-up memory and cognition power in older adults within 12 weeks [65]. Flavan-3-ol administration to human were reported to improve the blood levels of brain-derived neurotrophic factor (BDNF) which supports the growth and function of neural cells [66]. Others suggest that cocoa flavanols can increase the blood flow to the brain and thus can improve the memory and cognitive function in them [67-70]. Similarly, Ginkgo biloba, a polyphenol-rich plant extract, are found to improve the memory power, learning abilities, and concentration skills of the individuals [71].

Summary

Adequate intake of polyphenols-containing food/nutrients may bring several health benefits, as described above, however deficiencies of which are not necessarily result in any deficiency diseases (Figure.1). Tea, cocoa, fruits, and berries, as well as many vegetables are rich in polyphenols, and these polyphenols may help by preventing blood clots, reduce blood sugar levels, and lower the risk of having heart diseases [72-74]. Polyphenols are very potent to promote brain function, digestion, and also offer some protection against cancer. However, many controlled preclinical as well as clinical studies with age-related control, are needed to establish the conclusion. More importantly, the mechanism of their action must be revealed against the disease concerned.

The complex but highly important relationships between polyphenols and the gut microbiome should be considered mostly, and that warrant further research to reveal the mystery [75]. Furthermore, the possibility of any interactions with other bio-actives presents in foods like, fiber, terpenoids, and alkaloids should also be considered in the future studies, whether the combination could bring more comforts or aggravations of the disease conditions.

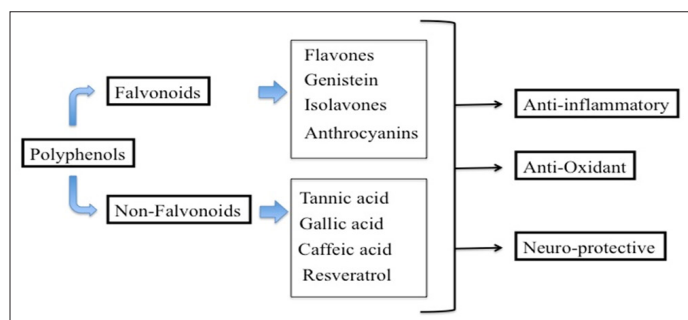


Figure 1: Polyphenols and their Beneficial Action-Mechanism on Human Health

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Authors Contribution

Both the authors contributed equally, in searching the information, writing and visualizing the concept.

Ethics Declarations

Ethical Approval

None.

Informed Consent

Not applicable.

Conflict of Interest

We, both the authors declare no conflict of interest, financial or otherwise. We also confirmed that we have read the journals' position on issues involved in ethical publications and affirm that this report is consistent with those guidelines.

Disclaimer

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