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Polyphenols: Types, sources and therapeutic applications

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Abstract

Polyphenols have been known for being rich and varied daily nutrients for us and play a very crucial function in the eradication of certain anomalies like heart diseases and cancer that are growing. Polyphenols' benefit on health is determined by the level absorbed as well as their bioavailability. The origin and types along with their contents found in different food resources of the various polyphenols, as well as their impact are important as these compounds provide many health advantages in the fight against diseases found in humans. Referring to a balanced food regime is always a crucial aspect in maintaining good health and nutrition in today's world. Certain researchers have deduced that a population that eats a certain meal (notably polyphenol-abundant regimens) have lower chances of developing a variety of chronic anomalies, including cancer, diabetes, coronary disease, obesity, and so on. Specifically, polyphenols and their types have been explored and reviewed making sure via its conclusions, future research on polyphenols becomes easier.

Keywords: Polyphenols, phenolic acid, flavonoids, food resources, health benefits

1. Introduction

In the past decade, polyphenols have made scientists and food developers progressively curious. This is largely due to the acknowledgement of polyphenols' inhibiting characteristics, their richness in our nutrition and their plausible role within aerobic pressure ailments such as neurodegenerative disorders and cancer. Polyphenolic compounds are the factors present in many healthy plants and alter the operations of a broad spectrum of enzymes and cell synapses (Middleton *et al.*, 2000) ^[1]. Polyphenols have many other biological substitutes that are reportedly poorly defined, besides having inhibitor attributes (Prabhu *et al.*, 2021) ^[2]. Two purposes in the analysis seem to determine evidence of the health consequences of polyphenol intake and to identify that of the several established polyphenols that seem to provide the best preventive nutritional protection. If these aims are to be obtained, the character, as well as dispersion of these metabolites in our meal, is first and foremost important. These data can permit analysis of polyphenol intake that may subsequently include a view of the connection between the application of these chemicals and thus the risk of many diseases working to develop. In addition, not every phenolic are equally efficiently absorbed. The vital organ enzymes as well as microflora rapidly convert them.

Crop remnants also have a lot more potential as an antioxidant source, and most of them are polyphenols. Polyphenol recovery from waste materials appears to be a suitable method for alienating these incredibly valuable, thermolabile components. However, polyphenol abstraction is hampered by two main issues: first, polyphenols can occur in living cells amalgamated with carbohydrates and amino acid complexes and otherwise they might form functional products which have an improved isolation tolerance, which is largely responsible for proper solvent selection as well as extraction terms and conditions (Kamal Gandhi *et al.*, 2018) ^[3]. The caseins from the milk are considered exclusive carriers for polyphenols, which might be due to their high proline concentration and self-association properties (Yildirim-Elikoglu & Erdem, 2018) ^[4]. The proline from bovine milk and colostrum exhibits anti-ageing properties, tissue healing and also enhance collagen production (H. Kumar *et al.*, 2015; H.

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Kumar, Kumar, *et al.*, 2014; Mehra, Kumar, Verma, *et al.*, 2021; Mehra, Singh, *et al.*, 2021) [5-8]. Polyphenols, on the other hand, are prone to oxidation. Their depletion is characterized by excessive temperatures, longer response periods, and an alkaline atmosphere. The most significant factor influencing antioxidant ability is solvent extraction capacity, which is generally connected to the phenolic material. Thermal and ultrasound detection methods are far more promising than alternative approaches, which also demonstrate stronger utilization as well as reliability in the separation of phenolic compounds with rich antioxidants (Brglez Mojzer *et al.*, 2016; Ranvir *et al.*, 2015) [9, 10].

Polyphenol usage serves a critical effect on health by maintaining nutrition, weight, chronic condition, and energy metabolism, according to an increasing gravity of data. Approximately 8,000 phenolic compounds have been recorded thus far, although their medium- to broad health impacts are still unknown. Several phenolic compounds contain anti-oxidative as well as anti-inflammatory characteristics which have therapeutic impacts, as per the plant, biological, and epidemiologic analyses. Most have been alerted; however, excessive consumption may be dangerous, especially if molecules were indeed extracted instead of getting ingested inside food composite. Polyphenols from active compounds work in tandem with natural antioxidants and enzymes to defend the body from oxidative damage triggered by free radicals (Prabhu *et al.*, 2021) [2]. Dietetic phenolics are one of the most abundant and commonly dispersed active product types mostly in the plant kingdom. While polyphenols are technically described as

compounds with phenolic structural elements, they are a diverse category of organic products that includes numerous threads of phenolics. The growing number of studies on dietary supplements with antioxidant content is likely attributable to their potential antioxidant abilities, as well as their potential health benefits (Mehra, Kumar, Kumar, *et al.*, 2021; Tsao, 2010) [11, 12].

The use of phenolic compounds combinations does have a stimulating impact, resulting in a reduction in the required medicinal dosage of a specific polyphenol. Polyphenols in addition to current meds and therapies have also demonstrated positive effects and significantly decreased toxicity. A good lifestyle is also critical for preventive care; the most essential element is a nutritious diet rich in fruit and veggies that provide substantial polyphenol blends (Brglez Mojzer *et al.*, 2016; Singh, Kaushik, & Gosewade, 2018) [9, 13]. In order to evaluate its bioactivity in many target cells, data concerning biological availability as well as metabolism of different polyphenols have to be taken. The discussion of the whole review is the classification and delivery of polyphenols in food items, their sites and nutritional benefits.

2. Types and distribution of polyphenols in food

Various thousand polyphenolic molecules (i.e., numerous aromatic branches are donned with chemical moieties) are recognized within plants as well as several hundred other molecules are reported in plant species (Cutrim & Cortez, 2018; Rasouli *et al.*, 2017; Tsao, 2010; Williamson, 2017) [12, 14-16]. Such molecules are phytochemicals and generally protect against UV or microorganisms' belligerence.

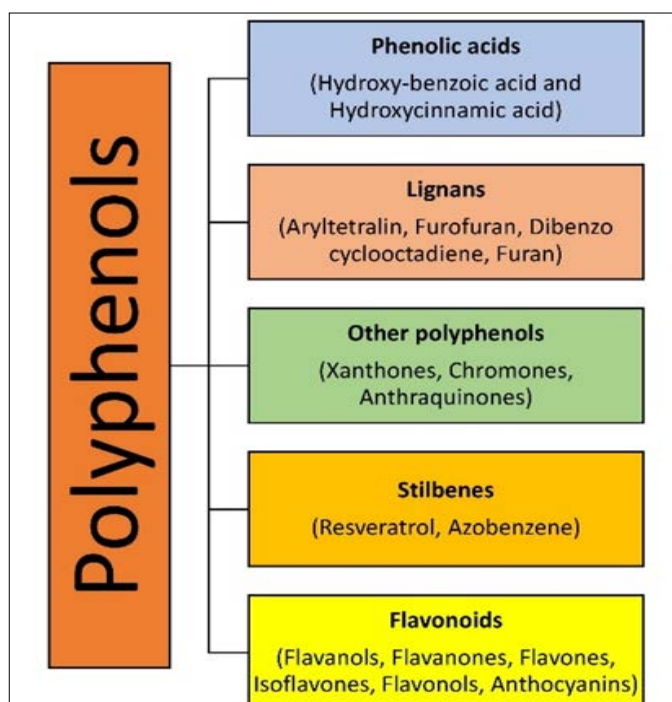


Fig 1: An overview of different types of polyphenols

Such compounds can indeed be divided into the distinctly new team to accomplish the percentage of phenol rings they encompass and also the structural elements that connect these rings. Even as the category of heterocyclic ring engaged may be executed in 6 subclasses, the flavonoids that have a remarkable similarity consisting of two benzene rings bonded together via three carbon atoms which structure oxygenated rings: flavanols, coumarins, flavanones, flavanol and anthocyanidins (proanthocyanins and catechins) (Cutrim &

Cortez, 2018; Prabhu *et al.*, 2021; Tsao, 2010) [2, 12, 14]. Polyphenols can also be linked with each other and interconnected with numerous organic simpler sugars concerning current diversity. An overview of different types of polyphenols is presented in Figure 1.

2.1 Phenolic acid

Two categories of phenolics exist benzoic acid derivatives and cinnamic acid derivatives. Hydroxybenzoic acids are

heterocyclic aromatic acids with powerful antioxidant and cancer-fighting properties. Gallic and ellagic acids, found in abundance in nuts and fruits, are the most prominent representatives (Lall *et al.*, 2015)^[17]. Gallic acid, according to certain studies, is particularly well consumed when compared with numerous polyphenols (Manach *et al.*, 2005)^[18]. The metabolites of 50 milligrams of crude gallic acid (found in 0.80–5.0 liters of red wine) tapped 4.0 mol/L after ingestion. This acid, on the other hand, can be found in a variety of types in red wine, tea, vegetables and nuts including its inert value, esterified in sugar (such as hydrolysable tannins), and esterified into proanthocyanins or catechin (such as compressed tannins). Ellagic acid, a natural hydroxybenzoic acid that is used in a variety of flowering plant families 106. It is mostly found in plants as glucosides or as a component of ellagitannins, which are hydrolysable tannins (glucose esters) (Santos *et al.*, 2013)^[19].

The content of hydroxybenzoic acid throughout plant foods is relatively low apart from some red fruits, onions and black radish that could amount to several milligrams per kg of raw weight. Tea and its leaves can have up to 4.50 g of crude gallic acid per kg (Tomas-Barberan & Clifford, 2000)^[20]. Hydroxybenzoic acids are furthermore discovered in different compounds (ellagitannins from strawberries, gallotannins through mangoes, blackberries, raspberries (Clifford & Scalbert, 2000)^[21]). These free or even esterified hydroxybenzoic acids existing in just a few edible plants, are not extensively researched and are considered to have a substantially less nutritional value at present.

The forerunner to such complex phenolic compounds as hydroxycinnamic acid in almost all plants is indeed cinnamic acid. P-coumaric, ferulic, caffeic and sinapic acid are the hydroxycinnamic acids more prevalent than hydroxybenzoic acids (Yang *et al.*, 2001)^[22]. These acids are hardly available in their pure form except in food products with fermentation or extremely cold sterilizations. The most typically found hydroxycinnamic acids are ferulic and caffeic acid (Cutrim & Cortez, 2018)^[14]. A very readily available polyphenolic compound in most fruits is caffeic acid, contextually free as well as esterified, representing between 75 and 100 % of total hydroxycinnamic acid. Caffeic acid is derived from various types of fruits, including tomatoes, apples, grapes and plums, despite its name. The esterified version of ferulic acid in cereal cell walls persists in pure form and is therefore ingested suitably (Manach *et al.*, 2005; Prabhu *et al.*, 2021)^[2, 18]. Ferulic acid, the primary source of nutrition, has to be the most potent phenolic acid in cereal crops. Ferulic acid can be mainly found in the outer coats of the grain. The pericarp and the aleurone layer of wheat grain contain 98 % of the total ferulic acid (Baniwal *et al.*, 2021; Chauhan *et al.*, 2018; Kaushik *et al.*, 2018)^[23-25]. The constrained forms are quinic acid, glycosylated tartaric acid, shikimic acid or aldehydes. The highest hydroxycinnamic acid content (0.50–2.0 g hydroxycinnamic acids/kilograms of fresh wt.) is found in kiwis, blueberries, apples and cherries (JJ, 1990)^[26].

2.2 Flavonoids

Flavanols have been omnipresent flavonoids of fruits where kaempferol and quercetin have been the principal members. They are typically present at a comparatively low 15.0–30.0 mg/kilogram fresh wt. concentrations. Origin of the wealthiest sources such as onions, curly pee, leek, broccoli and blueberries account for 1.20 g/kilogram fresh wt. The glycosylated forms of these compounds are present. Glucose or rhamnose are most commonly related sugars but can also

be associated with other sugars e.g., xylose, galactose, glucuronic acid, arabinose. The flavanols grow amongst the external and internal cells (skins as well as leaves) since light stimulates their bioactivity. Organic compounds like dichloromethane, diethyl ether, ethyl acetate or chloroform are used to extract methylated flavones, isoflavones, flavonols and flavanones which are lesser striking flavonoids (Rasouli *et al.*, 2017; Singh, Kaushik, & Jaglan, 2018)^[15, 27]. In fruits and green edible plants, flavanols are more popular than flavones (Prabhu *et al.*, 2021)^[2]. Luteolin and Apigenin are mostly composed of flavones. The skin of citrus fruits which have polymethoxylated flavones is such as sinensetin, nobiletin and tangeretin (at most 6.5 gram/liter mandarin and volatile oil). The most hydrophobic flavonoids are polyethoxylated flavones (Kudou *et al.*, 1991)^[28]. The parts of Kachnar (*Bauhinia variegata*) leaf, buds, flower, stem, bark and roots are adequate source of polyphenols i.e., quercetin and flavonoids which exhibits strong antioxidant properties (JJ, 1990; S. Kumar *et al.*, 2020)^[26, 29].

Isoflavones are structurally related flavonoids to oestrogen. Although they are not steroids, in a structure similar to hydroxyls in the estradiol molecule they have 7" and 4" hydroxyl groups. In leguminous plants, isoflavones are present almost exclusively. Soya and its variants are the chief isoflavones present in human daily food consumption Their concentration is normal 1:1:0.2 and consists of three primary compounds such as glycitein, genistein, and daidzein. These compounds are heat-sensitive and are broken down into glycosides in the course of industrial processes like soya milk manufacturing (Williamson, 2017)^[16]. Flavanone glycosidic forms are subdivided into 2 groups: Rutinosides, and Neohesperidosides. Compounds such as neoeriocitrin, neohesperidin, neohesperidoside as well as naringin are responsible for the perception flavor of grapefruit, bergamot and bitter orange juices. The didymin, narirutin, rutinoid and hesperidin flavanones are found among bergamot, mandarin, orange and lemon juices (Tripoli *et al.*, 2007)^[30]. The bioavailability of quercetin glucosides is more profound in comparison with quercetin rutinosides among humans, implicating that the small intestine promptly absorbs glucosides. The intake for quercetin varies from five to forty milligrams/day but can escalate by tenfold if the meal contains foods high throughout this compound, such as onions, strawberries and apples (Kudou *et al.*, 1991)^[28]. There are monomers (catechins) and polymers in the form of flavanols (proanthocyanidins) (Mehra *et al.*, 2020)^[31]. The most important fruit flavanols are Catechin and Epicatechin, while in some leguminous plants, grapes, and more specifically, Tea, gallicocatechin and epigallocatechin are present in gallate (Arts *et al.*, 2000)^[32].

Catechins, a Polyphenol having flavan-3-ols, have been extensively researched since they are the primary constituents of tea. A benzopyran structure containing phenyl group present at the second position along with the hydroxyl component belonging mostly to the third position is found in catechins. They come in monomeric and polymeric forms. They exist in both oligomeric or polymer blends forms but are not glycosylated. Fruits, vegetables, and teas are all good sources of catechins. Nuts, cereal, red wine, chocolate, tea and berries; thus, the projected nutritional status is indeed very large (12–189.2 mg/day). (+) catechin along with (-) epicatechin, can be frequently found in grapes and cocoa (EC) (Zhu *et al.*, 1997)^[33]. Galloyl esters of catechins (gallicocatechin) are the major catechins found in tea. Flavanols are not glycosylated in food in comparison to other types of

flavonoids. When exposed to warmth the pH is acidic, the tea epicatechins are surprisingly stable. The astringency varies during ripening and always disappears as a fruit reaches maturity. Polymerization reactions with acetaldehyde explain this transition well in the kaki fruit. Anthocyanin is a dissoluble pigment in the vacuolar section of the flora and fruit epidermal tissue to the colour of the rose, crimson, blue or violet. They are colored and colorless, depending on the pH, and occur in various chemical types. Red rice is also a good source of proanthocyanidins and anthocyanins (Mehra *et al.*, 2020) ^[31]. Though highly unstable in the form of aglycone (anthocyanidins), these compounds are resistive to factors such as oxidation, pH and light in plants and can cause their degradation. Conversion of these compounds with other flavonoids stabilizes anthocyanins. The most popular anthocyanidin in foods is cyanidin (Kudou *et al.*, 1991) ^[28].

2.3 Lignans

Lignans are by far the most widely distributed phytoestrogens since they are found as minor elements in so many other plants and are associated with the development of plant cell walls. Flaxseed meal and flour are the most common resources of lignans, especially matairesinol as well as secoisolariciresinol, however, they could also be present in concentrations ranging in vegetables, soybeans, fruits and whole grains (Prabhu *et al.*, 2021) ^[2]. Two phenylpropane units consist of lignans. Enterolactone and enterodiol through the gut microflora get metabolized into lignans. The low amounts of secoisolariciresinol and matairesinol consumed by us in our daily diets do not account for the levels traditionally detected in plasma and urine of metabolites enterodiol and enterolactone (Kris-Etherton *et al.*, 2002) ^[34]. Lignans are recognized for having the highest antibacterial activities of almost all of the olive oil's phenolic components and for hindering lipid peroxidation. Furthermore, partially macerated flaxseed (having flaxseed gum and lignans) brings down LDL by about eight per cent; however, similar flaxseed has already been shown to have pro-oxidant activity. Lignans, like isoflavones, have both estrogenic and antiestrogenic properties. These factors can play a large role in lignans' ability to avert the formation of breast, lung, colon, and skin cancer cells (Cutrim & Cortez, 2018) ^[14]. Early life access to lignans, including genistein, appears to affect mammary gland growth, resulting in a decrease in tumor growth (Lall *et al.*, 2015) ^[17].

3. Sources of polyphenols

Tea can contain as much as 4.5 g/kg wt., which can be a major source of gallic acid. Further elements of complexes like hydrolyzed polyphenols (red blackberry having ellagitannins and gallotannins within mangoes) form hydroxybenzoic acids (Clifford & Scalbert, 2000; Prabhu *et al.*, 2021) ^[2, 21]. Chlorogenic acid among a broad range of fruits and elevated coffee content is a combined form of caffeic and quinic acid; a cup can contain 70 to 350 mg chlorogenic acid (Clifford, 1999) ^[35]. The most concentrated phenolic acid is free and esterified, and the overall hydroxycinnamic acid content of most fruits varies from 75 per cent to 100 per cent. Both parts of the fruit have hydroxycinnamic acids but the outer portion in the mad fruit consists of the most content. Ferulic acid, the primary dietary source, has relatively more phenolic compounds present in cereal crops. The ferulic acid component of the various cereal meals is hence closely linked to sieving amount and bran

happens to be the principal resource of polyphenols (Hatcher & Kruger, 1997) ^[36]. Oat and rice meal have more or less equal phenolic acid content like a wheat meal (63mg/kg), whereas in maize flour content is almost three times as elevated (Shahidi & Naczsk, 1995) ^[37]. Almost 45 milligrams of flavonols per liter is also available within red wine as well as tea. Based on exposure to the sun, there are significant variations in concentration between the fruit present on similar trees at times also between different fruit portions. Likewise, glycoside levels are tenfold on leafy green external leavens compared to internal light-colored leaves of green vegetables like lettuce and colt. Flavonols concentration of cherry tomatoes is also more than that of normal tomatoes as the flavonols content varies from skin to whole fruit (Lu *et al.*, 2012) ^[38]. In the human diet, mint, tomatoes and some other plants as such contain flavanones, whereas are only contained in citrus produce at elevated concentrations. A glass of orange saw can contain flavanone glycosides between 40 and 140 mg. Since there are very high levels of flavanone in solid sections of citrus fruit, particularly in the albedo, and the membranes that separate the segments, the whole fruit can contain a glass of orange juice, up to a maximum of 5 times (Tomás-Barberán & Clifford, 2000) ^[39].

Soybeans have isoflavones around 580.0 to 3800.0 milligrams per kilogram of fresh wt. and soya milk has it somewhere between 30.0 and 175.0 milligrams per liter (Reinli & Block, 1996) ^[40]. A range of fruit and vegetables might well comprise catechins, the richest being apricots producing fresh wt. 250.0 mg/kilograms. We can also find them in red wine (up to 300.0 mg/L), but chocolate and green tea are the most copious foods by far. Almost 200 mg of catechins can constitute green tea extractions. Black tea generates lower monomers, that are oxidized by the 'anaerobic digestion (heating) of tea into more complicated polyphenols like theaflavin and thearubigin. Tannins are liable considering the astringency of fruits (kakis, strawberries, pears, grapes, peach, tomatoes, etc.) and alcohol (tea, beer, wine, vinegar etc.) and chocolate bitterness through the formation of salivary protein complexes. Anthocyanins are generally present in cereals, some red wines and some green vegetables (beans, aubergines, onions, radishes, lettuce) in the human diet, but they are most common in berries, blackcurrants or blackberries (Rasouli *et al.*, 2017) ^[15]. If the fruit ripens, these values rise. Except in some varieties of red fruit, where anthocyanins can also be present in the flesh, anthocyanins are often found in the skin (cherries and strawberries). Wine exerts production of 200–360 milligrams of anthocyanins per liter, and in the course of wine ageing, given anthocyanins convert to a spectrum of complicated forms (Clifford, 2000) ^[41]. A very minute number of Stilbenes is present in human food. Among these, resveratrol, has been widely investigated and has been proven to have anticarcinogenic properties during sampling of medicinal plants. It is contained in small amounts of wine.

4. Health benefits of polyphenols

In the words of Hippocrates, "Let food be thy medicine, and medicine be thy food," and food products' health impacts have been curated since time immemorial. Plant products, like fruits and vegetables, caters to the human body with calories and other vital nutrients, as well as playing an important role in human health (Mehra, Kumar, Kumar, *et al.*, 2021) ^[11]. Consuming phenolics regularly containing foods can help to minimize the onset of cardiovascular disease, sarcoma, liver disorders, obesity, diabetes and other as presented in Figure 2.

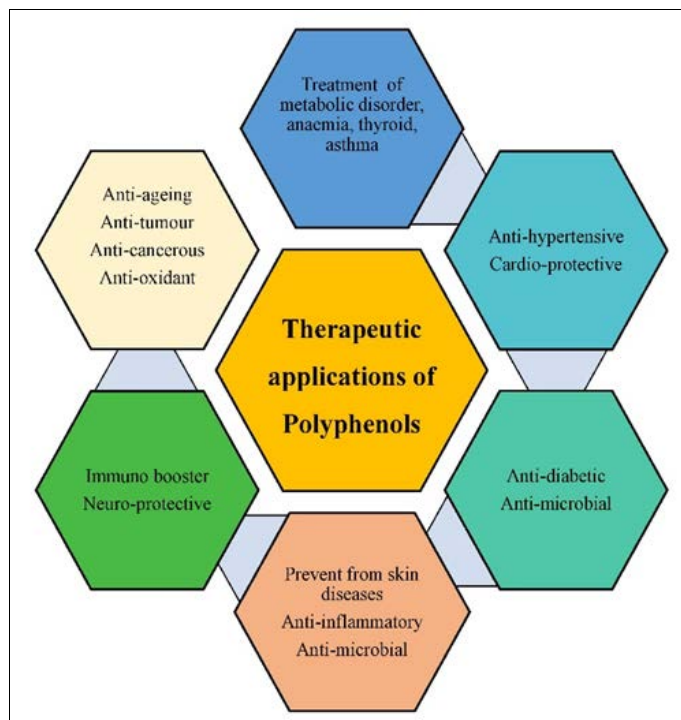


Fig 2: Health benefits of polyphenols towards human health and disease

These compounds are only synthesized in plants as protective mechanisms against physiological and environmental stimuli. Resveratrol, rutin, kaempferol, quercetin, catechins, and their variants, as mentioned in previous sections, provide various health benefits and are also known to have resistance against several human body disorders (mainly cardiovascular diseases, diabetes cancer, liver disorder infectious diseases and obesity) (H. Kumar, Choudhary, *et al.*, 2014) [42]. Fruits like apples, grapes, apricots, pears, cherries and tomatoes as well as vegetables like tomato, carrot, garlic, onion, celery and cabbage, consists of 200–300 milligrams polyphenols/100 grams of raw weight, making them suitable as polyphenol dietary supplements (Mehra, Kumar, Kumar, *et al.*, 2021; Yadav *et al.*, 2016) [11, 43]. Food and drug quality have increased as a result of the availability of such compounds in the edibles and pharma industries. Furthermore, due to their lesser adversaries in humans, these compounds are acknowledged as a healthy meal component. These compounds are essential for the oxidative stability of foods because of their antioxidant properties. Flavonoids have only recently been discovered to be effective in treating epilepsy. Epilepsy has been prevalent as a neurodegenerative condition, impacting 2–3 % population in the world and affecting large facets of one's standards of living. Polyphenols are the basic nutrients that cover human health by combating radicals generated by body tissues and averting oxidative pressure. A lot more studies are underway to determine the exact way flavonoids channelize in the human body. In different types of cancer cells, tea polyphenols can control as well as modify the gene expression of the COX-2 enzyme (Luceri *et al.*, 2002) [44].

Polyphenols, in-plant as well as animals can have a prominent role during oxidative stress because of their normal antioxidant activity. In damaged tissues, a liable inhibition for xanthine oxidase is found in polyphenols, mainly in luteolin. Silibinin is a flavonoid that can help prevent free radical development in chronic liver disease. Plenty of inactive leukocytes during the restoration of blood flow in arteries was stated to be reduced when an extracted flavonoid fraction was

provided orally. Polyphenols have been shown to determine the end product glycation receptors or RAGE as well as the inflammatory grouping it causes. RAGE speech has been found in a variety of organs, including the kidney, blood vessels, and adipose tissues. Polyphenols, especially curcumin, have been shown to reduce inflammation conditions and bring out better status physiologically in obese people (dependent on dosage). The advantages accounting for quercetin and meals high in quercetin have been tested in animal models in a study by Jung *et al.* (Jung *et al.*, 2011) [45] and the findings revealed that meals high in quercetin have pronounced results intolerance of sugar among rats with Type II diabetes. Dietary polyphenols are also utilized as an anti-obesity factor because they inhibit adipose tissue formation, suppress preadipocyte differentiation, promote lipolysis, also bring about apoptosis in withdrawing adipocytes by reducing the size of adipose tissue. The primary diseases associated with quercetin, according to a recent report, are cancer, diabetes, and digestive diseases. Obesity has also been a focus of quercetin therapies in a dose-dependent manner over the last 5 years. According to studies, a diet high in quercetin has an important impact on obesity. Shortly, such a compound would be ideally used to lose weight and fat. Quercetin is marketed as an outstanding antioxidant in several types of research, as well as anti-inflammatory properties, the ability to avoid cardiovascular disease, the ability to combat the flu virus, anti-allergy, non-growing characteristics and anti-ulcer as well as the ability to control gene expression (Prabhu *et al.*, 2021) [2]. The three most common chronic ailments that come under rutin treatment are cancer, hypertension, and hypercholesterolemia. Rutin is a soluble polyphenol with minimal toxicity in animal cells. This compound's anti-obesity behavior is ideally recorded among wide literature bodies over the past ten years (Guillermo Gormaz *et al.*, 2015) [46].

Catechins are profoundly present in the leaves of *Camellia sinensis* (Gadkari & Balaraman, 2015) [47]. Catechins have been shown to protect against degenerative diseases *in vitro*, and a reverse relationship linking utilization of catechin and

death menace from several heart diseases can be observed (Gadkari & Balaraman, 2015) [47]. Catechins are likely to be assertive against bacteria (Gram-positive) than Gram-negative bacteria. Chronic mouth infections including periodontal disorder as well as dental caries can be treated using catechins, according to new research (Higdon & Frei, 2003) [48]. Kaempferol is a promising cancer treatment target. Its ability to work on oxidants and classify multiple targeting pathways which cause apoptosis is undeniable (Chen & Chen, 2013) [49]. Aversion of cancer-causing genes and chemicals, as well as improving carcinogenic detox by involving steps, are two possible ways of kaempferol to bring about chemoprevention (Taraphdar *et al.*, 2001) [50].

5. Conclusion

To date, the various analytical analyses of polyphenols in foods have given a clear estimate of polyphenol distribution. Polyphenols are primarily seen in fruits or beverages such as coffee, red wine also in tea, although they can also be found in tomatoes, leguminous seeds, and cereals. In epidemiologic studies, research on polyphenol relevance would help us to correlate polyphenol intakes with plasma and tissues, resulting in possible health effects. Even though there has been a wide variety of studies on polyphenols, it seems that our current understanding of these compounds is at the most basic level possible, and further work with a focus on numerous strategies is needed to assess the effect of such compounds on human health and also to gain a deeper knowledge of bioactivity. To deduce the precise effect of these phytochemicals in curbing severe human anomalies, further genomic and proteomic research is required. The findings from this curated study, with a wide range of resources on phenolic derivatives and polyphenols, suggest that polyphenols, specifically phenolic bodies, flavanols, kaempferol, catechins, and lignan, can prevent fat overproduction, reduce cancer risk, stabilize insulin compatibility, minimize inflammation in tissues, as well as reduce red blood cell production. More studies are required to recognize the significance of these compounds in the human population and plants. A constant analysis of polyphenolic compounds is firmly proposed, which will explore the straight biochemical function of these compounds in human beings.

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