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Herbal plants used in antioxidant activity-A review

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Abstract
There are numerous medicinal plants and foods that contain a wide range of antioxidant properties. Antioxidants that are produced in the body (endogenously) or acquired through diet (exogenously) protect or safeguard our bodies by preventing oxidative damage, which is greatly exacerbated by free radicals. Free radicals are unceasingly produced, causing massive damage to tissues and bioactive molecules. As a result, herbal medicines with antioxidant properties are utilised as a medication to treat diseases caused by oxidative stress. Antioxidants found in nature like polyphenols and carotenoids have numerous biological properties, which includes anti-inflammatory, anti-aging, anti-atherosclerosis, and anti-cancer properties. Effective antioxidant retrieval and accurate assessment of antioxidant sources from food and medicinal plants are essential for investigating significant antioxidant sources and encouraging their use within food supplements, pharmaceuticals additives. The current study provides detailed information on free radical scavenging activity, lipid peroxidation, and primary sources derived from food and medicinal plants.

Keywords: antioxidant activity, DPPH, phenols, flavonoids

Introduction
Antioxidants are compounds that slow or prevent oxidation. Oxidants have high catalytic activity, and deleterious action toward biomolecules, DNA, and fatty acids. All such species can be generated from oxygen (ROS) or nitrogen (NOS). The widely known receptive oxygen species are hydrogen peroxide (H_2O_2), reactive hydroxyl radicals (OH) and superoxide anion (O_2). Nitrogen- inferred free radicals usually involve peroxynitrite anion (ONOO), nitric oxide (NO), nitrogen dioxide (NO_2) and dinitrogen trioxide (N_2O_3) [1]. Free radicals produced unceasingly, causing massive damage to tissues and bioactive molecules, furthermore eventually prompting an assortment of illness conditions. Oxidation is a chemical process in which an electron is transferred from a molecule to an oxidising agent. Free radicals can be produced during oxidation reactions, which can set off chain reactions that destroy cells. Free radicals are very reactive compounds with an unbound electron that play essential roles in natural processes like vascular tone control, antitumor activity, and neurotransmission [2]. Many human diseases are caused by free radicals including cancer, Alzheimer's disease, cardiac disease, etc. These are the substances that inhibit oxidation and can mitigate the harmful effects of oxidation in body tissue. They protect against free radical damage [3]. Stilbenes, lignans, Flavonoids, tannins, coumarins, phenolic acids are normal phenolic intensifies found in therapeutic plant parts which are responsible for antioxidant action. Antioxidants are most often found in delicacy supplements, and their possible impact in the treatment of diseases [4]. Hence this review highlights some antioxidants from plant origin.

Plants with antioxidant property
Allium cepa
Family: Amaryllidaceae
Antioxidant activity: Increased fruit and vegetable intake has been connected to a reduction in strand breakage caused by reactive oxygen species and, consequently, cancer development. Flavonoids, which are found all over the kingdom of plants explored for their antioxidant properties. Anthocyanins and flavonoids quercetin and kaempferol, are found in onions. However, the anthocyanin shades found in the external casing of red onions are small components of consumable piece. While kaempferol can be found in some onion assortments, it is substantially less abundant than quercetin. Hence, quercetin is the essential flavonoid in onions [5]. Mechanisms include chelation of transition metal ions, radical-scavenging, and hindrance of oxidases. Extracts from the upper layers of onions have powerful anti-free radical properties. By suppressing lipid peroxidation and lowering low-density lipoprotein (LDL) cholesterol levels, onion consumption has been related to a decreased risk of dementia, several types of malignant development, glaucoma, peptic growth, and the mitigation of cardiovascular events [6]. One of the antioxidant effects is the ability of onions and their extracts to reduce

rancidity in cooked meat [7]. Quercetin inhibits the lipoxygenase enzyme actively, I-tocopherol intake and protects human serum paraoxonase, although they have strong antioxidant action towards peroxidation of lipids. Metal chelation is the arrangement of a group with the flavonoid and the counteraction of catalytic radical synthesis, though free radical scavenging is the flavonoid giving a proton and making a steady radical [8].

Alpinia Galanga
Family: Zingeberaceae
Antioxidant Activity: A. galanga has more antioxidant activity due to essential oils. It has been reported that it has substantial free radical scavenging activity in methanolic and aqueous extracts against the radical 1,1-diphenyl-2-picrylhydrazyl (DPPH). The antioxidant activity was lower at acidic pH and higher at neutral pH [9]. The ethanolic extract of A. Galanga also demonstrated superoxide scavenging activity, reducing power and Fe^{2+} chelating activity. It does, however, have lipoxygenase inhibitor activity. Dichloromethane (DMC) and methanol extracts of A. Galanga rhizome have dose-dependent antioxidant activity, which has also been reported [10].

Antirrhinum majus
Family: Plantaginaceae / Veronicaceae
Antioxidant property: A. majus oil has enhanced radical scavenging activity (RSA) than virgin olive oil against galvinoxyl radicals and 1, 1-diphenyl-2-picrylhydrazyl (DPPH). The Snapdragon (Antirrhinum majus) plant's absolute methanol extract and fraction were tested for antioxidant activity. Total phenolics, IC50, and percent inhibition in linoleic acid oxidation were all assessed. Sunflower oil was chosen as an oxidative substrate to study the antioxidant action of plant extracts and fractions. By fixing the sunflower oil as an oxidative substrate, the free fatty acids (FFA), peroxide value (PV), conjugated dienes (CD), conjugated trienes (CT), and para-anisidine quantities were all obtained. Furthermore, it was found to protect plasmid pBR322 DNA from H2O2-induced oxidative damage, indicating that the plant has antioxidant properties [11].

Arachis Hypogaea
Family - Fabaceae
Antioxidant activity - Peanut peptide demonstrated in vitro antioxidant properties such as hydroxyl and DPPH radical scavenging and reducing power. Flavonoids secluded from the water-soluble portion of peanut were revealed to feature free radical scavenging action along with anti-protein glycation effects [12]. The majority of peanut stilbenoids inhibited the intracellular output of reactive oxygen species in PMA-induced HL-60 cells (ROS). Three stilbenoids compounds had the greatest antioxidant activity. Twelve compounds showed subsequently higher antioxidant activities than Trolox. Despite the fact that a lot of stilbenoids were moderately toxic to HL-60 cells, the antioxidant action impact was found at markedly lesser quantities [13, 14].

Arctitum Lappa
Family: Asteraceae
Antioxidant activity: A. lappa hydroethanolic extract has higher radical scavenging action. The largest phenolic proportion was found in the dichloromethane and hydroethanolic extracts. Arctigenin, chlorogenic acid, caffeic acid and quercetin were among the phenolic compounds studied. Only dichloromethane extracts demonstrated action on cancer cell lines, specifically MCF-7 and K562 [15]. The presence of caffeoylquinic acid derivatives was found to be responsible for A. lappa's free radical scavenging activities. The lignans from A. lappa, on the other hand, had anti-proliferative and apoptotic effects on leukemic cells. Arctigenin inhibited tumour growth in pancreatic cancer cell lines [16].

Asparagus officinalis
Family: Liliaceae
Antioxidant Activity: The antioxidant capacity of asparagus juice was tested using the β, β,,- diphenyl-l-picrylhydrazyl and β, β,,- azinobis (3-ethylbenzothiazoline-6-sulfonic acid) processes. Except for pectinase from Rhizopus sp, the compounds generally have rutinase, which hydrolysed rutin to quercetin. The highest quercetin content was found in asparagus juice treated with viscozyme [17]. Antioxidants were observed in anthocyanins A1 and A2 isolated from Asparagus officinalis spears. The effect of various freeze-dried Asparagus officinalis concentrations on the lipid profile and oxidative state of rats provided a cholesterol-rich diet was investigated. Doses of asparagus officinalis reduced LDL cholesterol amounts after five weeks of treatment. Asparagus consumption developed antioxidant state and safeguarded against peroxidation of lipids [18]. Erythrocyte hemolysis, Superoxide dismutase and 2, 2-diphenyl-1-picrylhydrazil free radical scavenging techniques were utilized to explore the antioxidant effect of Asparagus officinalis. In all three assays, the *in vivo* developed plant extract had the maximum antioxidant capacity, trailed by the in vitro developed plant extract [19].

Avena sativa
Family: Poaceae
Antioxidant activity: Many antioxidants were found in oats (Avena sativa) (phenolic acids, flavonoids, nonflavonoid and vitamin E) which demonstrate antioxidant activity. They found that phenolic-rich oat portions had a cancer prevention agent that was evaluated by their capacity to restrain LDL oxidation and protein

oxidation. Compounds extricated with methanol had the most significant level of antioxidant capacity [20]. Three Avenanthramides compounds were secluded from the seeds of Avena sativa. Spectroscopy revealed that they are 4,5-dihydroxyanthranilic acid amides with caffeic, p-coumaric, and ferulic acids, respectively. The antioxidant activities of seven common varieties of whole oat groats were evaluated. When compared to other whole grains, all oat variants had very much the same oxygen radical absorption capacity. The effect of allium sativum extract by enzymatic hydrolysates on human dermal fibroblast destruction caused by hydrogen peroxide was investigated. According to 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity assays, oat peptide-rich extract has antioxidant action. In human dermal fibroblasts, oat pre-treatment effectively reduced the H2O2-induced fall in superoxide dismutase (SOD) and suppressed malondialdehyde (MDA). The findings show that oat peptides have antioxidant action and are potent against H2O2-induced human dermal fibroblast destruction by increasing SOD action and less MDA levels [21].

Bacopa Monera

Family: Scrophulariaceae

Antioxidant activity: EBm (Bacopa Monera) by lowering free radical build up in the cerebrum, bacosides or extract boost the system's defences against oxidative stress. In an initial review, the antioxidant action of EBm was observed in the prefrontal brain, striatum, and hippocampus of rodents. Following 14 and 21 days of persistent EBm consumption, the enzyme activity implicated in scavenging reactive oxygen species, specifically SOD, GPx and CAT and was increased in these cerebrum districts of rodents [22]. Curiously, a similar report analysed the antioxidant study impacts of medication deprenyl, which further developed antioxidant action in the rodents' prefrontal cortex and striatum. They hypothesised that EBm's mental activity was caused by the increased free radical scavenging action of bacosides. Also, in another review, the influence of antioxidant action in diabetic rodents was achieved through a huge expansion in CAT, SOD, GSH and GPx levels, demonstrating a critical inversion of redox instability and peroxidative degradation to strengthen the defence system against ROS [23]. In a recent *in vivo* and in vitro study, they compared the impacts of 3-nitropropionic corrosive (NPA), a parasitic poison that influences neurotoxicity in animals and humans, to the effect of an ethanolic concentrate of EBm in the mitochondria of rodent brain and dopaminergic (N27) cells. As anticipated, the NPA elicited oxidative stress in the striatal mitochondria, but pre-treatment with EBm forestalled the NPA oxidative reaction and decreased GSH and thiol levels [24]. Pre-treatment with EBm and Bacoside A shows averted peroxidation of lipids and assume a part in antioxidants by regulating the impacts of catalysts (SOD, cytochrome P450 and Hsp 70 in the rodent cerebrum) identified to be associated with the ROS scavenging, leading in anti-stress action in rodents. EBm has additionally been displayed to either apply antioxidant action through chelation of metal at the beginning of the free radical chain response by chelating ferrous ions, or to be associated with free radical detoxification at the propagation level by chelating ferrous ions [25].

Bellis perennis

Family: Asteraceae

Antioxidant properties: The antioxidant [1, 1-diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging, total antioxidant and reducing action of plants were examined. The DPPH scavenging activity of the apical region was increased in aqueous extracts than in methanol extracts. Both extracts demonstrated reducing potential, with the aqueous extract producing higher linoleic acid peroxides than the methanol extract of the apical regions [26]. The antioxidant action of the aerial parts of Bellis perennis aqueous and ethanolic extracts was also determined using 1,1-diphenyl-2-picrylhydrazyl (DPPH) free-radical scavenging and ferric thiocyanate (FTC) methods. Using the DPPH method, the extracts demonstrated inadequate radical scavenging activity [27]. Apigenin-7-O-ghicopyranoside (ApG), a flavonoid segregated from Bellis perennis L. flowers, demonstrated significant in vitro antioxidant efficacy due to its ability to remove hydroxyl radicals and nitric oxide, as well as its ability to restrain the accumulation of thiobarbituric acid-reactive compounds. At the maximum ApG concentration, these parameters were suppressed at rates of 77.7 percent, 72 percent, and 73.4 percent, indicating that ApG impedes acetyl cholinesterase and useful in the diagnosis of neurological conditions [28]. The antioxidant action was determined using IC50 values ranging from 65.02 to 88.29 g/ml, which is approximately ten times lower than ascorbic acid, quercetin butylhydroxytoluene and Trolox® and approximately five times more than apigenin-7-glucoside. Total phenolics and antioxidant activity have a strong link between them [29].

Brassica nigra

Family: Brassicaceae

Antioxidant properties: The extract's total antioxidant capacity was determined to be 98.01 mg/g ascorbic acid. In the DPPH method, The IC50 value of Brassica nigra was 6.09g/ml, while the standard antioxidant had an IC50 value of 14.45g/ml. The standard antioxidants' reducing potential values such as quercetin, gallic acid and ascorbic acid were 485.75 percent, 740.10 percent, and 772.02 percent, respectively, while Brassica nigra had a value of 263.69 percent. The extract had an IC50 value of 121.18 g/ml for NO scavenging activity, while ascorbic acid had a value of 6.18 g/ml and quercetin had a value of 15.4 g/ml. Brassica nigra leaves and seeds methanol extract has antioxidant activity over a concentration range of 10-500 g/ml. It grew in proportion to the concentration. Callus derived from Brassica nigra hypocotyl explants was tested for antioxidant and antibacterial action on pathogenic bacterial strains. It was found that calli obtained through light incubation had higher

antioxidant and antibacterial activity than calli obtained through dark incubation. It was also discovered that older calli had higher total phenolic deposition, higher antioxidant activity, and stronger antibacterial activity [30].

Canna indica
Family: Cannaceae
Antioxidant property: In vitro antioxidant action of the plant's aerial parts methanolic extract was investigated using various techniques (DPPH radical scavenging, nitric oxide scavenging, hydrogen peroxide and hydroxyl radical scavenging techniques). Its free radical scavenging action was calculated and the DPPH radical scavenging, hydroxyl radical scavenging, hydrogen peroxide and nitric oxide techniques all revealed absolute retardation of 76.70 percent, 74.36 percent, 61.37 percent, and 62.84 percent, respectively [31]. Canna indica seeds methanolic extract had a DPPH antioxidant activity. The anthocyanins (Cyanidin-3-O-(6''-O-rhamnopyranosyl)-glucopyranoside, Cyanidin-3-O-(6''-O-rhamnopyranosyl)-galactopyranoside, Cyanidin-3-O-glucopyranoside, and Cyanidin-O-galactopyranoside) derived from Canna indica [32].

Calendula officinalis
Family: Asteraceae
Antioxidant properties: Calendula officinalis' in vitro antioxidant action was assessed through various methods, and it was revealed to have a dose-dependent impact on various radicals [33]. The *in vivo* and in vitro antioxidant effect of Calendula officinalis extract was analysed. Calendula officinalis extract has been shown to scavenge superoxide radicals produced by photoreduction of riboflavin and hydroxyl radicals, as well as inhibit in vitro lipid peroxidation. Calendula extract reduces superoxide generation by 12.6 percent and 38.7 percent in macrophages *in vivo* at doses of 100 and 250 mg/kg bw, respectively. Catalase activity was significantly increased in mice after a month of oral dose of Calendula officinalis. The extract increased glutathione levels in the blood and liver markedly. After Calendula extract administration, glutathione reductase was observed to be higher, however glutathione peroxidase was observed to be lower. Propylene glycol extracts of the petals and flower heads were quantified for antioxidant effects by peroxidation of lipid using urine malondialdehyde (MDA), plasma, and isoprostanes inventories. The results showed that the extract of the petals was highly efficacious. A remnant aqueous extract extracted with 70% methanol, chloroform, n-butanol, ether and ethyl acetate, demonstrated antioxidant effect via liposomal lipid peroxidation-induced Fe^{2+} and ascorbic acid. In vitro antioxidant action of Calendula officinalis butanolic fraction (BF) was investigated. In the presence of increasing concentrations of BF, superoxide radicals O and hydroxyl radicals OH are seen in declining amounts, with IC50 values of 1.0 to 0.09 mg/ml and 0.5 to 0.02 mg/ml including both, indicating free radical scavenging effect [34].

Capsicum annum
Family: Solanaceae
Antioxidant properties: Antioxidant compounds and antioxidant activity in sugary bell peppers (Capsicum annuum L.) of different colours were studied. The radical - scavenging strategy of peppers was defined using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) approach. Antioxidants found in Capsicum annuum L. have been shown to be beneficial in protecting food and the human from oxidative destruction brought about by reactive oxygen and free radicals. The main antioxidant components were capsaicin and dihydrocapsaicin. Their antioxidant activity was determined using heat-induced oxidation in the α-carotene linoleic acid system, and their radical scavenging action was determined using the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) decolouration method. In the DPPH system, quercetin 3-OR- L-rhamnopyranoside had the maximum radical scavenging activity and the actions of capsaicin and dihydrocapsaicin were analogous to trans-p-feruloyl-D-glucopyranoside. The antioxidant action of five pepper (Capsicum annuum L.) species reaped during a similar season, geographic region, and climatic circumstances [35]. Capsicum annuum's utilisation for a long-time enhanced serum lipoprotein oxidation resistance in adults, and capsaicinoids' antioxidant properties gave extra advantage in the treatment of cardiovascular disorders [36]. When female albino rats were administered red pepper or a similar amount of capsaicin coupled with a cholesterol-containing meal, the rise in liver cholesterol levels was reduced. The antioxidant activities of carotenoids obtained from dried Capsicum annuum were investigated. Guajillo pepper carotenoid extracts had the highest antioxidant action and DPPH cation scavenging activity (24.2 percent) [37].

Clove
Family: Myrtaceae
Antioxidant activity: Many fragrant herbs and flavours, especially clove buds and seed oil, have a variety of biological activities, including antimicrobial and antioxidant properties [38]. The radical scavenging effects of clove bud extracts and their constituents were determined. Because of their hydrogen-donating ability, clove buds' extracts decolorize DPPH when combined with it. The scavenging action of the volatile isolate of clove buds was quite strong for all quantities ranging from 42-83 percent. The high proportion of phenolic compounds including eugenol (72.28 percent), eugenol acetate (9.01 percent), and thymol in hexane extract may account for its remarkable antioxidant activity (0.87 percent) [39]. In comparison to commercial antioxidants BHT, dichloromethane and ethanol extracts, as well as recovered flavonoids of S. aromaticum buds found to be effective free radical scavengers. At various concentrations all the extracts and isolated flavonoids demonstrated

antioxidant activity against DPPH radicals. Free radicals exert a key role in the autoxidation of unsaturated lipids in meal [40]. At 400 mg/mL, quercetin has a moderate antioxidant activity (46%) compared to BHT (70%) at 50 mg/mL. Quercetin is an antioxidant that removes oxygen-free radicals and hinders the xanthine oxidase enzyme. When compared to synthetic antioxidants like BHT, the ethanol extract of clove buds demonstrated the highest scavenging action (93%) of all the extracts tested (95 percent). These findings show that S. aromaticum buds extracts and separated flavonoids have powerful actions as hydrogen donors and fundamental antioxidants by responding with lipid radicals [41].

Rumex acetosa

Family: Polygonaceae

Antioxidant activity: The antioxidant action utilising the ferrylmyoglobin/ABTS+ approach was evaluated, and their antioxidant capacity was represented in milliMoles of Trolox (TEAC). The TEAC of methanol extracts of analysed plants was more than that of extracts from other solvents. Sweet basil, coffee bean, sorrel and wild thyme extracts all had antioxidant actions [42]. Both the antioxidant action of the heated water extract of the leaves and the ethanol concentrate of R. acetosa were analysed. This activity was discovered using an *in vivo* method. In a dose-dependent manner, the plant's ethanol extract depicted potent DPPH radical action [43]. R. acetosa was noted to have powerful radical scavenging potential, with an IC50 value of 1.87 0.06 g/mL [44].

Conclusion

According to the current review, antioxidants have a crucial function in averting oxidative stress and some degenerative conditions. Medicinal plants have been considered as a viable player. The evaluation demonstrates that the majority of plant-based extracts and compounds are helpful in minimising a number of disorders; nevertheless, additional research is required to realise the full therapeutic potential. *In vivo* studies are also needed to isolate bioactive chemicals from medicinal plants and determine their effects on different health improvements or control of free radical-mediated illnesses. This information might then be used as a cost-effective assessment of health and well-being.

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