

MEDICINAL PLANTS AS POTENTIAL SOURCE OF ANTIOXIDANT AGENTS: A REVIEW

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ABSTRACT

All over the world, the recent scientific studies revealed the medicinal properties of plants, which have been examined, because of their effective pharmacological activities, economic viability, and their low toxicity. Reactive oxygen species (ROS) enhancement by endogenous and exogenous stimuli can modify redox circumstances of normal cells. To balance ROS-mediated cellular damage, endogenous antioxidants' protection system subsists; however, when oxidation surpasses the control mechanisms, oxidative stress increases. Detrimental alterations induced in a variety of biomolecules such as proteins, lipids, and DNA which causes chronic escalation of oxidative stresses, which ultimately causes tissue damage and results in numerous diseases. Antioxidants reduce the effects of ROS and help us in the prevention of such diseases. Antioxidants can either be natural or synthetic. Natural antioxidants can be obtained through diet in the form of fruits, spices, vegetables, etc. Synthetic antioxidants such as butylated hydroxytoluene and butylated hydroxyanisole also diminish oxidation, but they have been proved to be dangerous to humankind; therefore, investigation for non-toxic antioxidants has increased in the recent years.

Keywords: Antioxidants, Free radicals, Medicinal plants, Phytochemicals.

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INTRODUCTION

Antioxidants

Antioxidants are the compounds that stop or reduce the oxidation of other compounds. A typical definition of oxidation is the amalgamation of any compound or constituent with that of oxygen. For this reason, the term oxidation comes. It originates from the French word *oxider*, coined by Guyton de Morveau and Antoine Lavoisier in 1787 from the words *oxygene* and *acide*. These two words, i.e., *oxygene* and *acide* were united to form the single word *oxide*. The processes such as oxidation and reduction that is gain of oxygen and loss of oxygen, respectively, take place concurrently, and therefore, the reaction is said to be redox reaction. The term *oxide* has various meanings on the basis of different scientific areas [1].

Antioxidants are naturally found in foods but in very low concentrations. Hence, to control the oxidation, supplementary amount is added to recover the whole quality and to increase life period by a mechanism known as free radical termination [2]. In human body, various processes involving biochemical and physiological activities generate by-products in the form of oxygen-centered free radicals and reactive oxygen species (ROS), which in higher amounts results in the oxidative harm to biomolecules such as carbohydrates, proteins, lipids, and DNA. Ultimately, many chronic diseases may arise [3]. Antioxidants also give protection from harm originated by abandoned ROS production and associated lipid peroxidation (LPO), breakage of deoxyribonucleic acid strand, and protein damage [4]. At physiologically virtual levels, a perfect antioxidant has to be freely absorbed, chelate metal redox and quench free radicals [5].

Free radicals are associated with the development of a number of chaos in human body such as cell death, tissue damage, atherosclerosis, arthritis, cancer, injury of central nervous system, cardiovascular diseases, obesity, and ischemic heart diseases. To get rid of such diseases of free radicals, antioxidants are needed which can protect the individual life [6]. Shortage of antioxidants, which are able to reduce or quench the free radicals, supports the progression of degenerative diseases, such as neurodegenerative diseases, for example, Alzheimer's disease, cardiovascular diseases, for example, cancers, and inflammatory diseases [7].

Antioxidants played a significant role in health defensive mechanisms. Methodical indication recommends that antioxidants diminish the risk for chronic diseases such as cancer and heart diseases. The whole grains, fruits, and vegetables are the major sources of naturally producing antioxidants. The antioxidants such as phenolic acids, carotenes, Vitamin C, and Vitamin E obtained from plants have been documented to have the capability to decrease the risk of diseases [8]. Synthetic antioxidants such as butylated hydroxyanisole (BHT), BHT, tert-butylhydroquinone (TBHQ), and propyl gallate (PG) from food were used extensively. Chelators are also used widely because of the pro-oxidant consequences of transition metal ions including copper, magnesium, and iron in the food-producing industries. Concerning the well-being of certain man-made antioxidants as latent carcinogens, there has been sturdy concern and debate for many years. These synthetic antioxidants were still stay on the list of generally recognized as safe, but drawbacks of their use have been employed in United States, whereas BHT, TBHQ, and PG at a standstill require sanction in various states. Consequently, there is emergent significance by food industry and the users in replacing these man-made antioxidants with alternatives of naturally produced substances that have been supposed to be harmless and have extensive purchaser acceptance [2], and the curiosity to utilize natural antioxidants has been increased worldwide.

Plants have been regarded as the primary source of secondary metabolites showing fascinating biological actions. Normally, these chemical constituents are the chief sources of a number of structural preparations and properties [9]. Well-known examples of these secondary metabolites involve phenols, flavonoids, phenolic glycosides, cyanogenic glycosides, and saponins [10].

Worldwide, the recent scientific studies revealed the medicinal properties of plants, which have been examined, because of their effective pharmacological activities, economic viability, and their low toxicity [11]. For many years, natural products particularly plants are being utilized for the curing of a number of diseases. From pre-historic times, terrestrial plants were used in India, China, Greece, and Egypt and a remarkable number of fresh medicines were isolated from them. The uses of medicinal plants in written records have been reported

from the Sumerians and Alkaidians in about 2600 BC [12]. According to the World Health Organization, it has been estimated that 80% of the world's population depend on folklore medicine for their chief health-care necessities and this remedy mostly involves the extracts from plants and the bioactive constituents present in them [13].

There is growing tendency in comparing the phytochemicals obtained from medicinal plants and their pharmacological actions. Recently, it has been reported that the natural antioxidants from therapeutic plants defend from lethal and detrimental consequences of free radicals. The antioxidants have broad range of pharmacological activities such as anti-allergic, antimutagenic, antimicrobial, anticarcinogenic, and free radical antioxidant scavenging activity [5,14].

SOME ASSAY METHODS USED TO ESTIMATE ANTIOXIDANT CONTENT PRESENT IN NATURAL PRODUCTS

Antioxidants, such as phenolic compounds (phenolic acids, flavonoids, and tannins), showed wide range of biological properties, including anticarcinogenic, anti-inflammatory, and anti-atherosclerotic effects, because of their antioxidant activity [15]. Although numerous assays are available to find out the antioxidant activity. Some reported methods include 1,1-diphenyl-2-picrylhydrazine (DPPH) radical scavenging assay, 1,1-diphenyl-2-picrylhydrazine (DPPH) radical scavenging activity [16], ferric reducing antioxidant power assay [17], oxygen radical absorbance capacity assay [18], total radical trapping antioxidant potential assay [19], LPO method [20], superoxide anion scavenging activity [21], 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) radical scavenging method [22,23], hydroxyl radical scavenging activity [24,25], reducing power assay [26], thiobarbituric acid method [27], and Folin-Ciocalteu (FTC) method [28].

Among all the methods available to evaluate antioxidant activity, DPPH and ABTS methods are found to be most common and consistent, and in recent years, these methods have been modified and processed for improvement. Some of the methods are briefly described as under:

DPPH method

The method DPPH free radical scavenging assay was first illustrated in 1958 by Blois, and later on, it was modified to some extent by various researchers. For plant samples, it is one of the most comprehensively used assays to measure antioxidant ability of natural products. This method depends on the scavenging ability of DPPH through adding up an antioxidant or a radical species into the DPPH solution, resulted in the decolorization of that solution. It is most stable free radical scavenger that reacts with substances and can provide a hydrogen atom. Then, the antioxidant activity is calculated by reducing in absorption at 515 nm. This method has been done by preparing the DPPH (0.1 mM) solution in methanol, and then, the prepared solution of 4ml is supplemented to 1 ml of the sample solution in methanol changing concentrations. The absorbance of the mixture is then calculated at 517 nm after 30 min. The absorbance of the mixture decreased on large scale suggests considerable free radical trapping ability of the compound [7].

ABTS radical scavenging method

This method was first developed in 1994 by Rice-Evans and Miller; later on, it was modified in 1999 by Re *et al.* This modification is based on Metmyoglobin activation by adding hydrogen peroxide and ABTS⁺ to generate a radical cation. Through the reaction of ABTS and potassium persulfate, this improved process produces a blue-green ABTS⁺ chromophore and is now extensively used. The ABTS radical scavenging method besides DPPH method is one of the comprehensively used antioxidant methods for plant products. The reduction of ABTS to ABTS radical cation in the presence of potassium persulfate is measured at 734 nm spectrophotometrically. This method is used for the calculation of total antioxidant ability of hydrophilic as well as lipophilic substances. The antioxidant concentration effect and duration of radical cation inhibition should be kept in mind at the time of determination of antioxidant activity of the sample. Trolox, 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid, an analog of

the Vitamin E is a water soluble applied as a positive entity, and the antioxidant activity is communicated in terms of trolox-equivalent antioxidant capacity/mg of the extract [7].

Reducing power assay

The antioxidant activity of the plant extracts is resolved by the method known as reducing power method [26]. In this method, the extract in 1 ml of methanol is mingled with 5ml of phosphate buffer (0.2 M) at pH 6.6 and 5 ml of 1% potassium ferricyanide and then incubated the mixture for 20 min at 50°C. After that 5ml of 10% trichloroacetic acid was added and centrifuged the reaction mixture for 10 min. at 3000 rpm. Then, 5 ml of the solution from the upper layer is mixed with 1 ml of 1% ferric chloride and 5 ml distilled water, and at 700 nm, absorbance is calculated. A powerful absorbance signifies the amplified reducing power.

FTC method

The total phenolic content of the plant sample is determined by the FTC reagent assay [28] in a simple and inexpensive way. Although without any methodical optimization or justification, several modifications were made since from years. In this method, 0.2 ml of the plant sample is intermingled with diluted 0.5 ml of FTC reagent. Before the addition of 0.2 ml of saturated solution of sodium carbonate, the mixture is kept at 25°C for 3 min. The reaction mixture is then allowed to stand for another 120 min and the absorbance of the mixture is measured at 727 nm. Calibration curve is obtained by the use of standard, i.e., gallic acid. The total phenolic amount of the sample is expressed in terms of gallic acid equivalents in mM/l of sample.

SOME MEDICINAL PLANTS WITH ANTIOXIDANT PROPERTIES

Since ancient times, utilization of medicinal plant and their products has improved due to their exerted advantageous properties such as antioxidant, hypolipidemic, hypoglycemic, and anticancer activities. Some of the plants with potent antioxidant activities are discussed below:

Zingiber officinale

Ginger (*Z. officinale* L.) belonging to the family Zingiberaceae is a perennial herb and has been utilized as a spice for more than 2000 years [29]. In numerous parts of the world, it is not only one of the commonly used species to increase the flavor and taste of the food but also a variety of prospective bioactive compounds is also found with effective pharmaceutical and biological properties. Mostly rhizomes of the ginger are used as a condiment and spice [30,31]. Ginger consumption has been reported to be fruitful in various stress-associated health circumstances, and among such problems, some of them include tumor progression [32], hypertension [33], diabetes-provoked renal, and pancreatic ailments [34]. In conventional system of medicine, it has been used against headaches, colds, nausea, arthritis, and muscular and rheumatic chaos [35]. In addition, it has also been proposed that bioactive compounds from ginger showed various properties including renoprotective [36], anticancer, anti-inflammatory [37], and antioxidant effects [38] are actually antioxidants.

In mammalian system, the antioxidant activity of the compounds from this spice involves only single or more than one process from, free radical scavenging activity, improving the antioxidant molecules in tissues, LPO suppression, reducing the inducible nitric oxide synthase activity, rousing the actions of endogenous antioxidant enzymes, hindering the oxidation of low-density lipoprotein (LDL), and reduction of the enzymes such as 2-cyclooxygenase enzymes and 5-lipoxygenase for metabolism of arachidonate [39].

The astringent compounds of ginger such as 6-paradol and 6-gingerol acquire anti-inflammatory and antioxidative properties. The antioxidant activity has been studied by *in vitro* due to the presence of total phenols in the extracts of ginger. The antioxidant effect of total phenols of ginger in which DPPH free radical scavenging surpassed to that of BHT and half maximal inhibitory concentration

(IC50) values for DPPH inhibition was 0.64/ $\mu\text{g}/\text{mL}$. The extract from ginger reduced the hydroxyl radicals to an amount greater than that of quercetin which is a potent antioxidant compound. 6-gingerol has chemoprotective and chemopreventive assets which are frequently related to that of anti-inflammatory and antioxidant properties, and it is a scavenger of peroxy free radicals. Phospholipid liposomes peroxidation decreased due to gingerol in the presence of ascorbate and iron ions (Fe^{3+}). Nitric oxide, a reactive nitrogen species, has been concerned to manipulate transduction signal and causes damage to DNA resulting in cancer development, but 6-gingerol is proved to be a strong inhibitor of synthesis of NO and is also a valuable defender against damage in lipopolysaccharide activated macrophages mediated by peroxynitrite [40-43].

Momordica charantia

M. charantia L. (bitter gourd) from the family Cucurbitaceae has been used in food and medicine from prehistoric times. *M. charantia* is also known by other names such as karela and balsam pear, and Mara in Thai. It grows in Africa, USA, Malaysia, Indian tropical and subtropical parts, the Middle East, and Thailand [44]. Many advantageous bioactive compounds have been isolated from this nutrient-rich plant, which showed number of powerful pharmacological activities such as antibacterial, antiviral, and anticancer [45,46]. In addition to this, it has strong anti-obesity, hypolipidemic, and antioxidant properties [47]. In one of the studies, the two extracts of *M. charantia*, using water and ethanol solvents, showed that both these extracts, i.e., water extract as well as ethanol extract possess strong DPPH radical scavenging activity as compared to Vitamin E, used as standard. The IC50 $\frac{1}{4}$ values for water extract, ethanol extract, and Vitamin E were 129.94 mg/ml, 156.78 mg/ml, and possess potent 172.21 mg/ml, respectively. In addition, these two extracts of bitter gourd showed a superior iron chelating activity in comparison to Vitamin E. In water extract of *M. charantia*, there is higher amount (62.0 mg/g) of total flavonoid content than ethanol extract (44.0 mg/g), and lesser total phenol content is found in water extract (51.6 mg/g) than ethanol extract (68.8 mg/g), but both these extracts of *M. charantia* possessed a strong antioxidant and free radical scavenging properties [48].

Cymbopogon citratus

C. citratus (DC.) also called as lemongrass from the Gramineae family, a plant cultivated in nearly all tropical and subtropical realms as a source of fundamental oils. In Peru, lemongrass is utilized in the preparation of soft drinks and is also used as a pleasant-tasting, aromatic herbal tea in all the areas where it is to be distributed. The decoction or concoction of its above ground parts has extensive use in traditional medicine. This plant is being suggested to cure disorders of digestive system such as nervous disorders, fever, inflammation, diabetes, and other health troubles [49].

It has been reported that the essential oil isolated from lemon grass has been used as a potential anti-inflammatory and antioxidant agent. To identify the functional groups present in the oil of this plant, FT-IR spectroscopic analysis has been done, which indicated the presence of functional groups such as O-H stretching, H-bonded, N-H stretching, -C=C-stretching, aldehyde/Ketone-C=O stretching, -C-H in plane bending, and -CH₃ bending. When compared to L-ascorbic acid (standard), lemon grass in different concentrations showed strong antioxidant activity against the modified LDL provoked cytotoxicity in peripheral blood mononuclear cells. This suggests that lemon grass is a promising antioxidant agent [50].

Another experimental study on lemon grass revealed that it contains the bioactive compounds such as caffeic acid, isoscoparin, isoorientin, isoorientin 2''-O-rhamnoside, swertiajaponin, chlorogenic acid, and orientin which were identified spectroscopically. In this study, two extracts of this plants were extracted, methanol and methanol/water, and were measured for effects of free radical scavenging using the methods such as 1,1-diphenyl-2-picryl-hydrazyl (DPPH) radical, enzyme xanthine oxidase (XO) inhibition, superoxide anion scavenging,

and also human erythrocyte LPO. The results obtained from the above said extracts showed effects in the DPPH radical assay and superoxide anion assay, and the values obtained ranging between 40 and 68% at 33 $\mu\text{g}/\text{mL}$ and 15-32% at 50 $\mu\text{g}/\text{mL}$ in erythrocytes. These extracts also take part in reducing the LPO, with values ranging between 19 and 71%, in the concentration of 500 $\mu\text{g}/\text{mL}$, but not showing any effect toward the XO at 50 $\mu\text{g}/\text{mL}$. In all the essays of antioxidant activity, methanol extract was the most effective [51].

Adiantum capillus-veneris

A. capillus-veneris also known as southern maidenhair fern belonging to the family Adiantaceae is one of the most important species and has been reported to have potential significance for nutritive and medicinal purposes. It has reported a number of bioactive compounds including carbohydrates, flavonoids, carotenoids, triterpenoids, alicyclics, and aoleananes. Due to the presence of these chemical constituents, this plant exerted various pharmacological activities such as anti-inflammatory, antiproliferative, analgesic, antimicrobial, neuroprotective, antioxidant, and many more [52].

It has been reported that the ethanol extract of *A. capillus veneris* showed excellent antioxidant activity in comparison to ascorbic acid used as a standard. It shows low IC50 values for DPPH assay and ABTS assay as 0.3986 mg/gm and 0.695 mg/gm, respectively. The outcomes achieved signified that leaves of *A. capillus-veneris* were endowed with free radical scavenging compounds and can be used as a prospective resource of nutrients and natural antioxidants [53].

Another study on *A. capillus veneris* revealed that the flavonoids extracted from this plant showed antioxidant activity both by *in vitro* and *in vivo* methods. When compared with synthetic antioxidants such as ethylenediaminetetraacetic acid, BHT, and ascorbic acid, the flavonoids of adiantum were estimated in scavenging abilities of superoxide anion, 1, 1-diphenyl 1-2-picryl-hydrazyl (DPPH) free radical, chelating potential of ferrous ion, and reducing power *in vitro*. The results showed approximate or significant antioxidant activity of flavonoids of adiantum in appropriate concentrations than that of synthetic antioxidants. *In vivo* activity of flavonoids of *adiantum* were also examined through acute mice liver injury experiment. In mice, the liver under the influence of CCl_4 demonstrated a major decrease in superoxide dismutase (SOD), glutathione (GSH), and catalase levels, but at the same time, considerable enhancement occurs in malondialdehyde (MDA) levels. Compared with the Group II that received only CCl_4 , the group that received Vitamin E and higher dose of flavonoids of *adiantum* showed considerable increase in SOD, GSH, and SOD activity, but simultaneously decreased the MDA activity. The whole process takes place in a dose-dependent manner, and the results obtained showed that the flavonoids of *adiantum* possess strong antioxidant activities [54].

Stevia rebaudiana

S. rebaudiana (Bert.), commonly known as candy leaf, sweet leaf, or sugar leaf belonging to the family Asteraceae, is a wild perennial herbaceous plant grows in sandy soil and is native to Paraguay [55]. Stevioside is the chief sweet compound extracted from the *S. rebaudiana* leaves [56]. Its sweetener components have been advocated to possess advantageous consequences on human health in such a way that they show antihuman rotavirus activities, glucose metabolism, antihyperglycemic noncarcinogenic [57], antihypertensive [58], and antioxidant properties [59]. In rats, the aqueous extracts of dried leaves of this plant provoke systemic and renal vasodilation results in natriuresis, diuresis, and hypotension in rats [60].

The antioxidant activity of dried leaves of *S. rebaudiana* extract has been studied by measuring DPPH radical scavenging assay, using in different concentrations in increasing order, i.e., 20, 40, 50, 100, and 200 $\mu\text{g}/\text{ml}$ in a dose-dependent way, and it ranges from 40.00 to 72.37%, in which it is 64.26-82.58% for ascorbic acid which was used as standard compound. The aqueous extract has 83.45 $\mu\text{g}/\text{ml}$ IC50

values which is 26.75 µg/ml for ascorbic acid in DPPH assay. The total phenolic content of this extract is measured by using FTC reagent which contained phenolic content in the concentration of 56.73 mg/g and is found to be extensively effective when compared to gallic acid which is used as reference standard. This extract reduced superoxide anions, hydroxyl radical, and nitric oxide as well with IC50 values 100.86, 100.86, and 98.73 µg/ml, respectively. The presence of greater quantity of phenolic compounds in the aqueous leaf extracts of *S. rebaudiana* showed its more powerful radical scavenging properties [59].

Datura fastuosa

D. fastuosa is commonly known by many names. It is an annual herbaceous plant belonging to the family Solanaceae. The various parts such as leaves, roots, and flowers in dried form have been used for epilepsy, skin diseases, wounds and burns, hemorrhoids, diarrhea, rheumatic pains, skin ulcers, hysteria, and painful menstruation. In Ayurvedic system of medicine, this plant has been considered to be bitter, narcotic, astringent, antiseptic, germicide, acrid, anodyne, and sedative [61,62].

The antioxidant activity of *D. fastuosa* was evaluated from the methanolic and hydroalcoholic seed extracts by measuring the total antioxidant capacity and total flavonoid, phenolic, proanthocyanidines, and flavonol contents. The IC50 was 28.34 µg/ml and 25.78 µg/ml of the methanolic and hydroalcoholic extracts of *D. fastuosa*, respectively, through DPPH assay. On behalf of methanolic extract of *D. fastuosa*, it has been found that the entire antioxidant ability, total amount of flavonoid content, total proanthocyanidines content, total phenolic content, and total amount of flavonol were 6.83 mg/g, 6.34 mg/g, 1.42 mg/g, 9.97 mg/g, and 5.37 mg/g, respectively, and the values for such parameters of hydroalcoholic extracts were 7.44 mg/g, 9.35 mg/g, 0.88 mg/g, 6.88 mg/g, and 5.36 mg/g, respectively [63].

The *Datura metel* leaves were also evaluated for antioxidant activity using different solvents such as methanol, chloroform, ethyl acetate, and n-hexane for extraction process, and the leaf extracts were used

for DPPH radical scavenging assay, reducing power assay, total amount of phenolic content, hydroxyl radical scavenging activity, and bleaching activity of β-carotene. The antioxidant activity was executed at four concentrations sorting from 25 to 100 mg/ml. Among all the leaf extracts of *D. metel*, the chloroform leaf extract showed utmost antioxidant activity by increasing concentrations [64].

Teucrium polium

T. polium L. Popularly known as felty germander, belonging to the family Lamiaceae, is a natural flower species composed of various numbers of species with credulous antioxidant activity. The leaves and flowers of this plant in combination are used as a rejuvenating infusion. This mixture is also used against diarrhea, gastrointestinal diseases, colds, fevers, stomach pains, and liver ailments. In view of said reference, the above ground part of this plant has been extracted with different solvents, such as petroleum ether, methanol, chloroform, and water. The flavonoids with antioxidant activity were isolated from the methanol extract, which were recognized as apigenin, 4-,7-dimethoxy apigenin, 3-,6-dimethoxy apigenin, and rutin having IC50 values as 30.3±2.1 µg/ml, 37.4±3.4 µg/ml, 31.5±3.4 µg/ml and 23.7±1.9 µg/ml respectively in DPPH assay. For methanol extract, the IC50 value for DPPH assay was 20.1±1.7 µg/ml, which is same as that of a synthetic compound BHT, used as antioxidant, having IC50 value as (18.3±1.9 µg/ml). The presence of affluent content of flavonoids, showing great antioxidant activity, in the extract of *T. polium* was used in many food substances as an alternative of synthetic antioxidants [65].

It has also been studied that the *T. polium* ethanol extract showed the effective antioxidant activity, same as that of α-tocopherol. Recently, the antioxidant activity was also studied on rats by *in vivo* method, where rats have been delighted with extracts of *T. polium*, which showed a considerable antioxidant activity as that of α-tocopherol (positive control) in the DPPH test. At the doses of 50 mg/kg and 100 mg/kg, the extracts of *T. polium* extensively amplified the total antioxidant power and reduced the thiobarbituric acid reactive substances in

Table 1: Some medicinal plants with antioxidant properties

Plant name	Common name	Family	Part used	References
<i>Zingiber officinale</i>	Ginger	Zingiberaceae	Rhizome	[37]
<i>Momordica charantia</i>	Bitter gourd	Cucurbitaceae	Whole plant	[48]
<i>Cymbopogon citrates</i>	Lemon grass	Gramineae	Aerial part, leaves	[51,50]
<i>Adiantum capillus-veneris</i>	Southern maidenhair fern	Adiantaceae	Whole plant	[54]
<i>Datura metel</i>	Datura	Solanaceae	Leaves	[64]
<i>Teucrium polium</i>	Felty germander	Lamiaceae	Aerial part	[65]
<i>Polyalthia cerasoides</i>	Cherry ashok	Annonaceae	Stem bark	[70]
<i>Crocus sativus</i>	Saffron	Iridaceae	Sepals	[71]
<i>Curcuma longa</i>	Turmeric	Zingiberaceae	Rhizome	[72]
<i>Azadirachta indica</i>	Neem	Meliaceae	Leaf	[73]
<i>Ocimum sanctum</i>	Tulsi	Lamiaceae	Leaf	[74]
<i>Terminalia bellerica</i>	Behda	Combretaceae	Fruit	[75]
<i>Solanum tuberosum</i>	Potato	Solanaceae	Tuber	[76]
<i>Foeniculum vulgare</i>	Saunf	Apiaceae	Seed oil	[77]
<i>Cuscuta reflexa</i>	Akashabela	Convolvulaceae	Stem	[78]
<i>Salvia officinalis</i>	Common sage	Lamiaceae	Root	[79]
<i>Litsea glutinosa</i>	Soft bollygum	Lauraceae	Stem bark	[80]
<i>Murraya koenigii</i>	Curry tree	Rutaceae	Leaves	[81]
<i>Cinnamomum tamala</i>	Tejpat	Lauraceae	Leave oil	[82]
<i>Allium sativum</i>	Garlic	Amaryllidaceae	Bulb	[83]
<i>Allium cepa</i>	Onion	Amaryllidaceae	Bulb	[83]
<i>Costus pictus</i>	Spiral ginger	Costaceae	Leaves	[84]
<i>Bacopa monnieri</i>	Brahmi	Scrophulariaceae	Leaves	[85]
<i>Plantago asiatica</i>	Chinese plantain	Plantaginaceae	Seed	[86]
<i>Arnebia benthamii</i>	Gaozaban	Boraginaceae	Whole plant	[87]
<i>Aloe vera</i>	Star cactus/Indian aloe	Asphodelaceae	Leaves	[88]
<i>Daucus carota</i>	Carrot	Apiaceae	Root	[89]
<i>Mentha Pulegium</i>	Pennyroyal	Lamiaceae	Leaves	[90]
<i>Cotinus coggygria</i>	Smoke tree	Anacardiaceae	Leaves	[91]
<i>Tamus communis</i>	Black Bryony	Dioscoreaceae	Root	[92]
<i>Aegle marmelos</i>	Bengal quince	Rutaceae	Fruit	[93]

rats, compared to the control [66]. *In vitro* studies of aqueous extract of *T. polium* can also efficiently reduce oxidative progressions with significant antioxidant activity [67].

Polyalthia cerasoides

P. cerasoides (Roxb.) commonly known as cherry ashok, belonging to the family Annonaceae, is a medium-sized evergreen tree found in about all the Deccan Indian forests at an altitude of about 3000 ft. The fruits of this plant have been used as food in tribal people of Indian states such as Andhra Pradesh and Tamil Nadu, while as African tribal people consumed the leaves, fruits, and roots of this plant, used to heal rheumatism, aphrodisiac, toothache, and deparasitant, and also used as an anti-inflammatory agent. The stem bark of *P. cerasoides* has been confirmed after various pharmacological investigations reduced the brain stress [68,69].

The antioxidant probability of alcohol extract of stem bark of *P. cerasoides* has been estimated using different essays including DPPH assay, superoxide anion scavenging assay, hydroxyl radical assay, and reducing power assay. The methanolic extract of stem bark of this plant displayed a momentous DPPH scavenging activity inhibition in a dose-dependent manner. 50% inhibition showed at 25 µg/ml concentration corresponding to tannic acid. In superoxide anion scavenging assay, the alcoholic extract acquires the efficiency of 50% inhibition at the concentration of 80 µg/ml corresponding to tannic acid indicated by the decrease in the absorbance of the plant extract at 560nm. For hydroxyl radical, the alcoholic extract showed 50% inhibition, in the concentration of 50µg/ml corresponding to tannic acid. This extract can also reduce the Fe³⁺ to Fe²⁺ ions. The total amount of phenolic content in the alcoholic extract of this plant was articulated as 0.589 µg of tannic acid comparable to per mg of extract. In all the *in vitro* antioxidant tests, the stem bark extract of *P. cerasoides* confirmed considerable ROS scavenging activity and restrained elevated amount of total phenolic levels [70].

CONCLUSION

Cellular harm of human body comes up from free radicals or ROS and appears a basic mechanism, involving a number of neurodegenerative chaos, digestive system disorders, inflammation, diabetes, viral infections, and autoimmune pathologies. From various laboratory experiments, it has been shown that free radicals and ROS are involved in these dreadful diseases. A variety of synthetic antioxidants are used in processed foods to defeat such ailments, but they show evidences of adverse side effects in humans. Several home-grown antioxidants may be valuable in preventing such effects of oxidative stress and have led to substantial attention in manipulating the antioxidant capability of botanicals, foods, and other nutritional antioxidant supplements. In the present study, some medicinal plants as shown in Table 1, for example, *Z. officinale*, *M. charantia*, *C. citrates*, *A. capillus-veneris*, *D. metel*, *T. polium*, *P. cerasoides*, *C. sativus*, *C. longa*, and *A. Indica* have been proved to possess valuable antioxidant properties as they contain a large number of secondary metabolites such as flavonoids and phenolics. In addition to antioxidant activity, these compounds are also used as anticarcinogenic, anti-inflammatory, antibacterial, antiviral and antifungal, antispasmodic, and antidiabetic.

CONFLICT OF INTEREST

The authors declared that they had no conflicts of interests.

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