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Antioxidant From Natural Source

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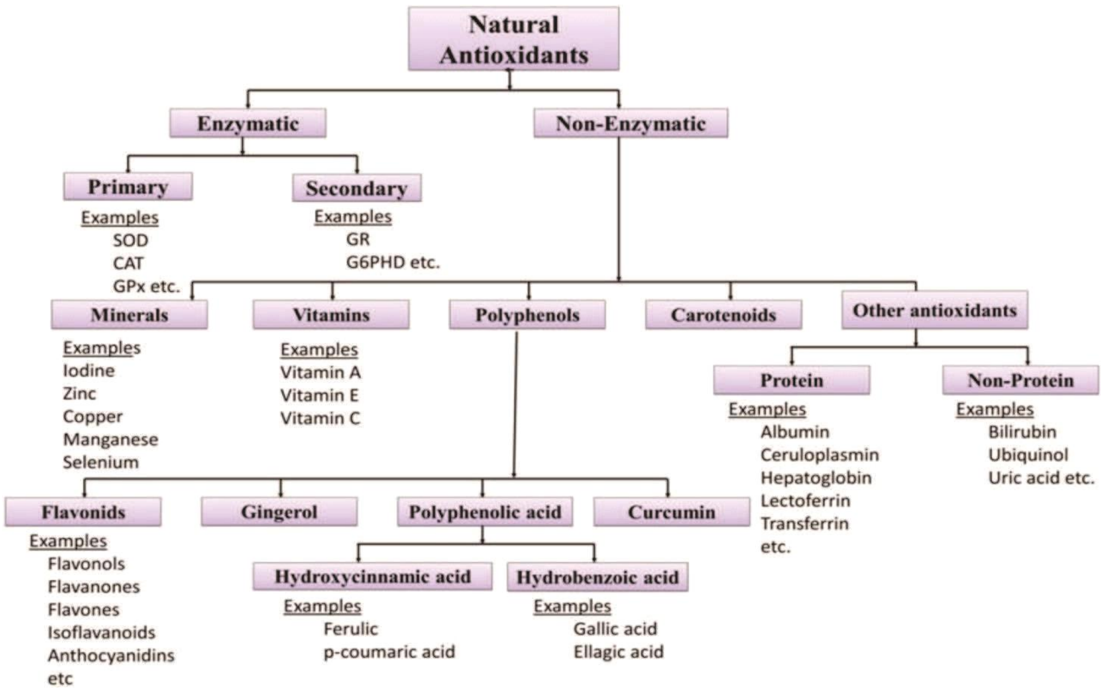
ABSTRACT :

Due to research revealing probable detrimental effects associated with the consumption of synthetic antioxidants, there has been a lot of interest in incorporating natural antioxidants in food products in recent years. Antioxidants can be found in a range of plant materials, including herbs, spices, seeds, fruits, and vegetables. The fascination with these natural components stems not only from their biological significance, but also from their economic impact, as the majority of them can be harvested from food waste and underutilised plant species. The current state of knowledge on natural antioxidants, including their sources, extraction methods, and stabilisation processes, is presented in this article. Recent studies on their applications in the food business, specifically as preservatives in various foods, are also discussed.

Keywords : Natural Antioxidants, Types of antioxidants from fruits and vegetables, Medicinal plants and spices having antioxidants **.**

Introduction



As a result of rigorous oxidative reactions, oxygen reactive structures are formed. The potent antecedents of systemic cell and tissue destruction can be found in the human body. Antioxidants, as oxidation inhibitors, eliminate these free-radical intermediates by oxidising themselves, even at very low concentrations, and so have a protective effect.Many physiological functions in the body to prevent these oxidation reactions and so protect the organism from hazardous chain reactions As a result, many researchers have considered them as nature's solution to physiological and environmental stress, atherosclerosis, ageing, and cancer. Endogenous defence system of the body Plays against the free radicals.[1] An important role, which can be bolstered by antioxidant supplementation in the diet. Antioxidants are split into two types in general: those that protect the body against free radicals and those that protect the body from the effects of free radicals.

To date, researchers all over the world have focused on finding natural sources of antioxidants that are both affordable and closer to nature. In the food, pharmaceutical, and cosmetic industries, these indings will be a preferable option for synthetic supplements. Though no significant negative effects of synthetic supplements have been discovered to date, a common notion of supplementation that is closer to nature is clearly a better strategy. The future decade will be the era of natural products, with researchers focusing their efforts on natural antioxidants.

The current chapter's major goal is to provide an overview and summary of natural sources having antioxidant potential. For both professionals and nonprofessionals, the summary data will be relevant information.[2]

Natural antioxidants

Nature is a constant and abundant source of several chemicals that can be used as health-promoting agents. Many of these natural sources can be found in everyday foods such as fruits, vegetables, herbs, spices, and edible mushrooms. Furthermore, there is a long list of medicinal plants that have been reported to have significant health-promoting properties. The possible antioxidant qualities of these natural sources are one of the most beneficial effects. In terms of antioxidant capacity, the experts have concentrated their research on the most promising sources as well as their active constituents.[3] Marine sources such as algae and seagrass have been added to the list of natural sources by the researchers. Recent research has also looked into.

Types of antioxidants from fruits and vegetables

Polyphenols, present in fruits and vegetables, is a group of several low- and high- molecularweight compounds having antioxidant properties that prevent lipid oxidation . Most of them are conjugates of mono and polysaccharides connected with one or more groups of phenol rings or may also present as functional derivatives such as esters and methyl esters . This major class of natural antioxidants can be obtained from teas, particularly green and red teas, as well as fruits such as grapes. However, polyphenols from teas have more signiicant than in fruits because of their bioavailability in blood. Approximately 15–20% polyphenols are absorbed in human blood from their consumed amount. This absorption is enhanced when there are no sugar molecules atached with them. So, teas have more absorption of polyphenols than in fruits because of high sugar content in fruits .

No	English name	Antioxidant contents	Concentration (ORAC value)
1.	Beet root	Betalains	
2.	Guava	β-Carotene, lycopene, vitamin C, ellagicacid, anthocyanin	
3.	Pears	Ascorbic acid, lavonoids (quercetin, isorhamnetin, myricetin, kaempferol, and luteolin), betalains, taurine, total carotenoids and total phenolics	135 (mmolTE/g)
4.	Pomegranate	Vitamin C and polyphenols	1245 (mmolTE/g)
5.	Papaya	Quercetin and β-sitosterol	300 (mmolTE/g)
6.	Water melon	Lycopene, β-carotene, vitamin C	100 (mmol TE/g)
7.	Apple	Proanthocyanidins, lavonoids (kaempferol, 16.78 a ± 0.25quercetin, and naringenin derivatives); phenolic acids (protocatechuic, cafeoylquinic, and hydroxycinnamic acid derivatives); hydroxychalcones (phloretin and 1508 ±44 3-hydroxyphloretin derivatives); and isoprenoid (μmol/100 g) glycosides (vomifoliol derivatives)	
		Flavanols, lavonols, dihydrochalcones, andhydroxycinnamates	

8.	Plum	Proanthocyanidins, lavonoids (kaempferol, quercetin, and naringenin derivatives); phenolic acids (protocatechuic, cafeoylquinic, and hydroxycinnamic acid derivatives); hydroxychalcones (phloretin and 3-hydroxyphloretin derivatives); and isoprenoid glycosides (vomifoliol derivatives)	14.55 c ± 0.21 (mmol TE/g) 94.8 (mmolTE/g)
9.	Guava	β-Carotene, lycopene, vitamin C, ellagicacid, anthocyanin	
10.	Beet root	Betalains, vitamins C and E, carotenoids, lavonoids, and thiol (SH) compounds	4100 (dry extract) 115 (μmol TE/g)
11.	Pea	Vitamins C and E, carotenoids, lavonoids, and thiol (SH) compounds	19 (μmol TE/g)
12.	Carrot	Vitamins C and E, carotenoids, lavonoids, and thiol (SH) compounds	60 (μmol TE/g)

Among the vitamins obtained from fruits and vegetables, acting as antioxidants, vitamin C, also known as ascorbic acid, is a very potent water-soluble antioxidant commonly found in citrus fruits and vegetables such as oranges, lemons , and tomatoes It is recommended that the fruits and vegetables containing vitamin C should be taken in small divided doses instead of having a large dose simultaneously because vitamin C shows less absorption when givenin large quantities .[4]

Another vitamin with antioxidant properties is vitamin E, which is related to tocopherol family of antioxidant. It is a fat-soluble, nonpolar vitamin found naturally in lipid-rich fruits and vegetables, such as olives, sunlower, and nuts . Vitamin E shows higher bioavailability than vitamin C, which is perhaps due to its fat solubility and can be further enhanced when taken with faty foods .

Armillaria mellea

A. mellea is a culinary-medicinal honey mushroom, used as an admired element in the traditional Chinese medicine. The mushroom is pathogenic and is found worldwide in temperate,

boreal, and tropical forests . It grows on living trees and on dead and roting sustenance material . Polysaccharides obtained from wild sporophores and reined products of *A. mellea* have scavenging properties . Two polysaccharides, AkPS1V-1 and AkPS1V-2, from the alkaline extract of the mushroom have been isolated and reported for their antioxidant activity . Moreover, their ascorbic acid and phenolic components have been reported for their scavenging impact on superoxide anions . Overall, it is reported to have a fair antioxidant capacity to be used as food oxidation-reducing substance.

Auricularia auricula

auricula is an edible mushroom, found worldwide, belongs to the family Auriculaceae, commonly known as tree-tea or wood-ear. The mushroom contains high quantity of carbohydrates including polysaccharides, proteins, minerals, and phenolic substances . Polysaccharides of the mushroom have antioxidant activity by the inhibition of lipid peroxidation and have efective hydroxyl radical scavenging activity . In the case of lipid peroxidation, IC50 values of ethanolic, crude, and boiled extracts of *A. auricula* are 398, 310, and 572 μg/ml, respectively, and in the case of hydroxyl radical scavenging activity, 373, 403, and 510 μg/ml, respectively . Khaskheli et al. isolated two polysaccharides from fruiting body of *A. auricula* and evaluated potential antioxidant activity of these polysaccharides . [5]Among its various extracts, the boiled extract, which is also convenient, proves to be more efective antioxidant.

Ganoderma lucidum

Ganoderma lucidum is also commonly known as Lingzhi, a basidiomycete fungus, native to China and grows in mountain woods with humid and dim-light conditions, in the roten bark or root of tree. The mushroom is well known as medicinal mushroom and has been prescribed to prevent and treat diferent diseases . *G. lucidum* contains polysaccharides, sterols, triterpenoids, nucleosides, and alkaloids . *G. lucidum* is called as marvelous mushroom of immortality because it shows that the consumption of the mushroom can prolong life . Shi et al. separated four polysaccharides from *G. lucidum* and investigate their antioxidant property. They demonstrated that these four polysaccharides have scavenging activities in a concentrationdependent manner . *G. applanatum* is known as shelf fungus and also belongs to *Ganoderma* species of the mushroom. *G. applanatum* exhibits the higher antioxidant property over *G. lucidum* and other two edible mushrooms including *L. edodes* and *Trametes versicolor*.[6]

Grifola frondosa

G. frondosa, also known as Maitake, is a culinary as well as medicinal mushroom native to China, North America, and northeastern part of Japan but cultivated worldwide in several countries because of its useful efects . The mushroom is progressively being perceived as a powerful wellspring of polysaccharide with sensational well-being and advanced potential. Total phenols, ascorbic acid, α-tocopherol, and lavonoids are the major scavenging agents present in the diferent *G. frondosa* extricates . *G. frondosa* polysaccharides have critical inhibitory impacts on hydroxyl radical, superoxide radical, and 1,1-diphenyl-2-p icrylhydrazyl (DPPH) radical [83]. Their ferrous particles chelating activity is also strong [84]. Fan et al. extracted ive polysaccharides from the natural product group of *G. frondosa* by various separating techniques. Hot alkali extract of *G. frondosa* has the beter antioxidant 13 activity as compared to partially puriied polysaccharides. It has the lower EC50 values of DPPH scavenging ability [86]. The study results enforce the variation of their antioxidant ingredients due to the seasonal and geographic displacement.

Hypsizigus marmoreus

H. marmoreus is an edible mushroom commonly found in East Asia including Korea, China, and Japan, widely known due to its antioxidant activity . Phenols and polysaccharides are the major bioactive components present in *H. marmoreus* that show the antioxidant activity by scavenging reactive oxygen species and strengthening its reducing power . Liu et al. investigated the intracellular polysaccharides of *H. marmoreus* and revealed that these polysaccharides can be utilized as an antioxidant agent that improves adaptive immune reactions .

. Lentinus edodes

L. edodes also known as shitake mushroom is the second most well-known consumable mushroom in the worldwide market and is usually cultivated in Indonesia, Taiwan, China, and Japan [90]. The mushroom is credited to its wholesome incentive as well as to conceivable potential for therapeutic applications . *L. edodes* contains some important polysaccharides that have therapeutic activity. The mushroom is also a good source of vitamins, particularly vitamin B, including B1, B2, B5, B12, and provitamin D2. *L. edodes* extract has potent antioxidant efect due to the presence of bioactive compounds ergothioneine . *L. edodes* has the ability to increase the total antioxidant capacity and reduce the total oxidative stress . UV-C radiation can improve scavenging capacity of *L. edodes* .[7] Chen et al. separated three types of polysaccharide from fruiting bodies of *L. edodes*, and they demonstrated the polysaccharides as potent antioxidant agents that can produce healthy immune response.[24] The treatment of mushroom crude powder or its extract may also helpful to enhance its antioxidant capability.

Pleurotus ostreatus

Pleurotus ostreatus is the third most cultivated mushroom worldwide after *A. bisporus* . Its mycelia as well as fruiting bodies have well-known therapeutic efects due to its various biologically active compounds including phenols, lavonoids, and carotenoids having strong antioxidant activity .[17] The methanol extract demonstrated the most grounded β- carotenelinoleic acid restraint when contrasted with alternate extracts. On the other hand, acetone has the strong reducing power than alternate concentrates.

Schizophyllum commune

S. commune is a standout among the usually discovered fungus and can be separated from all landmasses, aside from Antarctica. *S. commune* has been accounted for to be a pathogen of people and trees; however, it principally receives a saprobic way of life by causing white rot.[18] The antioxidant activity of *S. commune* is due to polysaccharides and polyphenols components .

Medicinal plants and spices having antioxidants

Allium sativum

A. sativum commonly known as garlic is a species belongs to family Alliaceae commonly cultivated in India . It is a perpetual herb with a tall, erect blooming stem that grows up to 3 feet.[19] Garlic has been utilized all through history for both culinary and therapeutic purposes. *A. sativum* is an adaptable herb that contains various trace elements, vitamins, and minerals. The total phenolic compound of the garlic has the antioxidant activity .[20] As an antioxidant, garlic has the strongest DPPH-scavenging ability . Aged garlic extract has signiicantly eminent total phenolic substance than raw garlic extract . It has been noticed that as the plant gets older, more the antioxidant potential it will gain.

Capsicum annuum

Capsicum annuum (red pepper) is native to southern North America and northern South America and was introduced in Asia in sixteenth century from South America . [21]It contains a wide cluster of phytochemicals with their radical-scavenging properties .[22] The spice contains carotenoids, lavonoids, tocopherols, free sugars, capsaicinoids, L-ascorbic acid, and organic acids . At the ripe stage, hot-dried peppers have a high bioactive substances that show huge free radical-scavenging properties such as polyphenols and carotenoids .[23]

Curcuma longa

Curcuma longa is a well-known spice that has a place in the Zingiberaceae family and is a lasting herb that measures up to 1 m high with a short stem. It is circulated all through tropical and subtropical locales of the world, being generally developed in Asiatic nations , primarily in India and China. In Pakistan and India, it is prevalently known as Haldi. As a powder, called turmeric, it has been in continual use as a lavor enhancer in both veggies lover and non-vegan foods. Essential oil of fresh rhizomes has higher scavenging properties . [8]The phenolic compounds of *C. longa* are the primary contributor of antioxidant activity .[25]

Eugenia caryophyllus

Eugenia caryophyllus commonly known as clove is a medium-size tree (8-12 m) that belongs to family Myrtaceae. *E. caryophyllus* has been utilized for a considerable length of time as nourishment additive and for some therapeutic purposes as well . [26]Clove is local of Indonesia yet these days also cultivated in some other countries including Brazil in the province of Bahia. This plant is one of the wealthiest sources of phenolic compounds, for example, gallic acid eugenol and eugenol acetate . *E. caryophyllus* leaf essential oil and its main constituent eugenol possess high antioxidant activity . Among various extracts, the methanolic extract has higher scavenging activity than acetone and chloroform extracts .[27]

Geranium sanguineum

Geranium sanguineum, usually called as bloody cranesbill, is a herbaceous plant that belongs to family Geraniaceae. It is local from Asia and Europe and is developed as a garden subject. In Pakistan, India, Sri Lanka, Indonesia, and Zanzibar, it is cultivated on large scale. It is found naturally in Madagascar, Brazil, Sri Lanka, Tanzania, and West Indies [28]. Methanol extract of *G. sanguineum* has the free radical-scavenging property .

Pistacia lentiscus

Pistacia lentiscus is extensively used in folk medicine by rural populations in Algeria. The herb is imperative due to its therapeutic uses. Ethanol, ethyl acetate, aqueous, hexane, aqueous/ hexane, and chloroform extracts from the leaves of *P. lentiscus* have the radical-scavenging activity . *P. lentiscus* have exceptional reducing power and strong radical-scavenging activity against DPPH .[29]

Salvia oicinalis

Salvia oicinalis, also known as garden sage, belongs to family Lamiaceae and possesses strong antioxidant property .[30] The plant is grown and cultivated in some parts of Iran. The leaves of the plant are utilized as a part of Iranian folk medicine. The antioxidant activity of the plant is due to the presence of polyphenol constituents . Dried sage leaves infusion with boiling water (sage tea) is the most typical form of preparation. Sage tea contains polyphenolic constituents that possess antioxidant property and other therapeutic efects .[31]

Uncaria tomentosa

Uncaria tomentosa is generally known as cat's claw and belongs to the family Rubiaceae. Its native is Amazon rainforest and other tropical territories of Central and South America. For centuries, the plant has been utilized as a part of customary practices in South America particularly in Peru. Due to its anti-inlammatory and radical-scavenging activities, the plant has been used to treat rheumatic diseases and cancer .[9] Decoctions prepared from the bark

of *U. tomentosa* are generally utilized as a part of the conventional Peruvian medicine for the treatment of many diseases . The bark decoctions have strong ability to decrease the free radicals diphenylpicrylhydrazyl, hydrogen peroxide, and hypochlorous acid .[32]

Leea indica

Leea indica belongs to the family Vitaceae and has been traditionally used as natural folk medicine in Malaysia. In the leaves of *L. indica*, 23 known chemical compounds are identiied . [33]The identiied compounds include 11 hydrocarbons, 3 phthalic acid esters, phthalic acid, gallic acid, ursolic acid, solanesol, farnesol, β-sitosterol, lupeol, and 1-eicosanol . Among these, total phenolic compounds possess the antioxidant activity

Polyalthia cerasoides

Polyalthia cerasoides belongs to the family Annonaceae and is a medicinal plant used in Thai native medicine. The roots of *P. cerasoides* are used for therapeutic purposes that contain alkaloid, bidebiline, three known sesquiterpenes, four known isoquinoline, and other compounds such as laudanosine, codamine, laudanidine, and reticuline .[35] The extract has the highest phenolic compound and high reactive oxygen species-scavenging activity .

Antioxidants from marine sources

Marine ecosystem has been reported as a potential source of biodiversity and chemical activities. The organisms living in marine environment are gaining the atention of industries such as pharmaceuticals, nutraceuticals, and cosmetics because of possessing various interesting and useful chemical compounds . Marine biotechnologists are trying to produce the tool for the utilization of marine biodiversity for the production of cheap source of pharmaceutical products and functional foods . Seaweeds and sponges are considered as the richest source of bioactive compounds having the antimicrobial and antioxidant activities . Seaweeds and sponges with their associated bacteria have been found to possess various health-promoting and disease prevention efects due to their phenolic compounds, polysaccharides, and useful organic acids . These are supposed to be the most protective group of foods against environmental pollutants and radiation . Among various other useful compounds, the marine organisms also contain polyphenolic compounds that are responsible for antioxidant activity including lavonoids, benzoic acid, cinnamic acid, gallic acid, quercy, and phlorotannins . Nonanimal sulfated polysaccharides are reported to have antioxidant activities , which can be obtained from marine algae and other marine organisms from the phaeophyta group.[36]

A large number of diferent species of algae and microalgae have been studied for the use of their bioactive contents as functional food components.[10] Algae comprised of a huge and complex group of photosynthetic organisms with simple reproductive organs, which can be multicellular, known as macroalgae and unicellular called as microalgae. Algae grow in extremes of environmental conditions such as light, temperature, and salinity, which results in the production of a large number of reactive oxygen species (ROS). [16]To cope with these ROS, algae produce various secondary metabolites with many antioxidant activities such as phycobilins, polyphenols, carotenoids, and vitamins .

People living in coastal areas use many types of seaweed, both as fresh and dry forms, as a natural source of food, and from the research, it is known that these seaweeds contain a large amount of proteins, minerals, and vitamins.[37] Although the composition of these seaweeds varies according to their species, geographical distribution, temperature, and seasonal variation, the overall nutritional value remains the same. Many compounds from marine algae possess anticancer activity, and recently, seaweeds have gained atention as a rich source of antioxidants . Many of the secondary metabolites produced by marine organisms relect the presence of chloride and bromide ions in seawater. Marine halogenated compounds assemble a large number of other useful compounds such as indoles, peptides, terpenes, phenols, acetogenins, and volatile halogenated hydrocarbons. This protective efect suggests the presence of antioxidant compounds that show their antioxidant activity as free radical scavengers, hydrogen-donating compounds, single oxygen quenchers, and metal ion chelators. Many biological compounds have previously isolated from some other marine organisms such as ish, crustaceans, and their byproducts .

Seaweeds also create a suitable environment to a large number of bacteria that live on their surface having much more diversity of microorganisms as compared to other multicellular organisms . These associated microorganisms have a protective efect on the seaweeds from pathogen, and they produce a large number of bioactive compounds of biomedical importance . Exopolysaccharides produced by these bacterial species are used as an ingredient in food, petroleum, and pharmaceutical industries and emulsiication of crude oil, vegetables, mineral oils, and bioremediation agents in environment management systems . [14]

Fish protein hydrolysate (FPH), which is prepared from various marine organisms such as mackerel, tuna, Alaska Pollock, and yellowin sole, has also been reported to have antioxidant activity . Many types of peptides are obtained from ish muscle, bone, skin, and other tissues. All of these amino acids can scavenge-free radicals, but the most powerful scavenging activity atributes to those who can easily donate hydrogen atoms. These amino acids are cystine and methionine, which have nucleophilic sulfur-containing side chains or tryptophan, tyrosine, and phenylalanine, which have aromatic side chains. [15]Peptide size and amino acid composition are important for the FPH because it determines its antioxidant nature .

An in vitro study on phycocyanin, a pigment obtained from blue-green algae, reveals its antioxidant activity. It was evaluated in vitro by the use of luminol-enhanced chemiluminescence (LCL). Luminol reacts with oxygen (O−2), alkoxyl ($RO^{\cdot}$), and hydroxyl ($OH^{\cdot}$) radicals and shows a luminous signal measurable before and after antioxidant addition. This antioxidant activity was also conirmed in vivo by induction of inlammation in mice paw with glucose oxidase. [11]The edema caused by inlammation was reduced, and the luminous signal indicated that the phycocyanin can scavenge $OH^{\cdot}$ and $RO^{\cdot}$. Algal antioxidants are also used in the cosmeceutical industries as antiaging agents . A carotenoid pigment known as astaxanthin, found in microalga *Haematococcus pluvialis*, is reported to have anti-inlammatory, immunomodulatory, and antioxidant activities .

Extraction Processes of Natural Antioxidants

As mentioned, many natural antioxidants are contained within vegetal matrices and their separation for further utilization is needed. Antioxidants can be extracted from different plant parts such as leaves, roots, stems, fruits, seeds and peels . The quality of natural extracts and their antioxidant power depends not only on the quality of the original source (e.g., geographic origin, nutritional aspects and storage) but also on the technologies applied for their extraction. So far, extraction processes have been mainly performed at laboratory-scales. Scale-up is not direct because it strongly depends, for example, on complex transport phenomena. However, some authors have already reported applicability at higher scales. Périno and Pierson , optimized the extraction of polyphenols from lettuce at a pilot scale by solvent-free microwave extraction. Saffarzadeh-Matin and Khosrowshahi , used solvent extraction for phenolic compounds from pomegranate waste, which was also successfully implemented at a pilot plant scale. In addition, Solana and Mirofci studied the scaling-up of the supercritical fluid extraction of phenolic and glucosinolate from rocket salad.

There is not one standard procedure for performing the extraction of all natural antioxidants, since each compound has its own chemical and physical properties, and they are present in quite different solid matrixes. Still, extraction using organic solvents is the most common process used. Along with conventional solvent extraction procedures, other strategies may be used, such as extraction with supercritical fluids, high hydrostatic pressure, microwaves and ultrasound . However, these more recent technologies usually present higher investment costs, but often lower environmental impact .[12] Table 3 summarizes some examples of methods used for the extractions of natural antioxidant compounds from different sources.

Extraction Process	**Source**	**Antioxidant Extracted**
Organic Solvents:		
Ethanol, dichloromethane,hexane	Coffee leaves	Chlorophylls and carotenoids
Ethanol, acetone andwater	*Baccharides* specie	Phenolic content
	Sweet potato	Polyphenols and anthocyanins

Extraction Process	**Source**	**Antioxidant Extracted**
	Spent coffee ground	Polyphenols
	Olive pomace	Phenolic compounds
Ultrasound-assistedextraction	Green propolis	Phenolic compounds
	Strawberry trees	Anthocyanins
	Carotenoids	Pomegranatewastes
	Blueberry pomace	Phenolic compounds
	Mango peel	Pectin and phenolic compounds

The extraction yield and antioxidant capacity are dependent on the solvent, on the conditions under which the process is carried out and on the extraction method used. Those factors may affect the amounts and qualities of antioxidants in the extracts; for example, due to breakdown and polymerization reactions . An efficient extraction is obtained when it is possible to extract the maximum amounts of the bioactive compounds with the lowest degradation degree of the compounds, and minimum amounts of non-antioxidant substances, such as sugars and organic acids .

Conventional Extraction Techniques

Solvent extraction (solid–liquid or liquid–liquid) involves the choice of solvents and the use of heat and/or stirring . A solid–liquid extraction process is normally executed in a Soxhlet apparatus,

where the plant material is placed together with a condensed solvent. The advantages of using Soxhlet include, among others, the repetitiveness of placing fresh solvent in contact with the solid matrix, and that no filtration is required at the end of the process. However, it has disadvantages, such as the need for large quantities of solvents, and consequently, an evaporation/concentration process; not having stirring during the process; and the possible thermal degradation of the compounds, as the process is usually carried out at the boiling point of the solvents for a long period of time .

When dealing with plant materials rich in a wide range of phenolic compounds, the extraction yield depends on various factors, such as the type of the solvent used (polarity), extraction temperature, time and solvent-to-plant ratio. The choice of the solvent depends on the nature of the compounds that are intended to be extracted, being that the extraction yield is influenced by their solubilities in the solvent to be used. Solvent-to-plant ratio should be optimized in order to use a suitable solvent concentration that prevents its saturation in molecules extracted during the extraction process . Since they may be attached to insolublecomponents, such as waxes, terpenes or fats, a preliminary solid-liquid extraction process may be required for the removal of the unwanted phenolics and non-phenolic substances . [13]

Different solvents have been used, separately or in mixtures, including ethanol , acetone , methanol , hexane and water . In the study of Peschel and Sánchez-Rabaneda , fruit and vegetable by-products (from red beet, apple, strawberry, pear, artichoke, asparagus, tomato, broccoli, cucumber, endive, chicory, golden rod and woad herb) were extracted with five solvents: water, methanol, ethanol, acetone and hexane. It was found that, in general, a higher yield resulted from a one-step extraction using water and methanol compared to the other methods. In contrast, the extraction of anthocyanins and polyphenols from grapes and red and black currants was more efficient using ethanol and methanol compared to water .[12] Additionally, Boulekbache-Makhlouf and Medouni , studied different solvents to quantify the total phenolics, flavonoids, tannins and anthocyanins in eggplant peel. They concluded that methanol was the best solvent for the extraction of anthocyanins, mainly because they are polar molecules, and acetone was described as the best solvent for quantifying the other compounds. Fu and Tu studied phenolics and anthocyanin extraction from sweet potato leaves with three solvents (water, ethanol and acetone). They reported that the extraction with 70% ethanol resulted in extracts with the highest total flavonoid and total anthocyanin contents. Though, 50% acetone was the solvent producing extracts with higher total phenolic content.

Although there are a large number of works in the literature focused on extraction yield, it is not clear which solvent is more effective for a specific raw material. From the food industry point of view, from all solvents mentioned, ethanol and water are the more adequate, as they have GRAS (generally recognized as safe) status .

Conclusion

An increasing interest has been observed from the past decade in exploring the natural ingredients to be used in the food and food products. The researchers from all over the world are

focusing on the alternate sources other than the synthetic one, which will be more safe and convenient as dietary component. Although there are no such harmful reports have been observed regarding the use of synthetic antioxidants however the consumer's interest is also compelling toward the nature close products. Moreover, the synthetic antioxidants and preservatives in the food may lead to lipid peroxidation and deterioration of food lavor and quality. The use of natural herbs, spices, and plant ingredients is in practice from the ancienttimes and still practiced in the traditional food preparation as preservative, aroma, and lavor. This chapter is an efort to overview the potentials of various natural sources having reasonable antioxidant potential. The literature reports compiled here will be beneicial to identify the signiicance of various natural sources based on their antioxidant capacity, active ingredients, and geographic availability. This chapter reveals that people can prioritize their dietary habits based on the antioxidant potential and cost-efectiveness of the available source because 70–80% of the world population cannot aford the modern supplement and medicines.

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