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Antioxidants from Natural Sources: Review

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ABSTRACT
In recent years, there has been great interest in the use of natural antioxidants in food products, as studies indicate possible adverse effects associated with the consumption of these antioxidants. synthetic antioxidants. Many plant materials are known to be natural sources of antioxidants, such as herbs, spices, seeds, fruits and vegetables. Interest in these natural ingredients is not only due to their biological value but also to their economic impact, as most of them can be extracted from food by-products and plant species. little exploited. This article provides an overview of current knowledge on natural antioxidants: origins, extraction methods, and stabilization procedures. In addition, recent studies on their application in the food industry are also discussed; in particular as a preservative in various food products and in active films for packaging and edible coating purposes.
Keyword: antioxidants, herbs, origins,preservative, stabilization procedures.

I. INTRODUCTION

Oxygen is an essential chemical element in the metabolism of aerobic organisms. However, it can cause adverse reactions and there is increasing interest in studying the role of its reaction types. Reactive oxygen species (ROS) include free radicals such as superoxide anions, singlet oxygen, lipid peroxides, and hydroxyl radicals. These reactive species are by-products of normal cellular energy production and functional activities, and play important roles in cell signaling, apoptosis, gene expression and ion transport. However, if ROS levels rise sharply, it can damage many molecules, including proteins, lipids, RNA and DNA, as they are highly reactive. The formation of reactive oxygen species is the result of rigorous oxidation processes that take place in the human body. are potent prodrugs that cause systemic cell and tissue damage. Antioxidants are oxidation inhibitors that scavenge these free radical mediators by oxidizing themselves. Since food products are not consumed immediately after production, but need to be stored and transported, suppliers must ensure that they are delivered to the consumer with safety and quality, and that nutritional value equal or higher at the time of production. There is a constant search for strategies to increase the overall quality and shelf life of food products, in many cases by reducing or inhibiting oxidation; The combination of antioxidants is one of the strategies to delay the oxidation of biomolecules. Natural antioxidants, easily obtained from natural sources, have great potential for use as preservatives, replacing synthetic substances.

NATURAL ANTIOXIDANTS

Nature has always been an important and rich source of countless ingredients that can be used as health boosters. Many of these natural sources include commonly used edible fruits, vegetables, herbs, spices, and mushrooms that can be part of a regular diet. On top of that, there is a huge list of herbal remedies that are said to have immense potential to improve health. One of the most beneficial effects of these natural sources is due to their potential antioxidant properties. When it comes to antioxidant capacity, researchers have focused their research on discovering the most potential sources and their active ingredients[1]. The researchers added several marine sources such as algae and seagrasses to this list of natural sources. Recent studies have also explored the role

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of natural microbiota in the gut in a group of body antioxidants known as good insects. These good bugs can also be used as a supplement known as probiotics. The resulting material is therefore an excellent database for researchers in the field and useful information for the general reader. It is necessary to summarize this huge database based on identifying most potential sources, which will make the material accessible to both professional and nonprofessional readers. This chapter will expand on different natural sources of antioxidants, hopefully helping to prioritize beneficial changes in dietary composition. Fruits and vegetables are highly recommended dietary staples, widely known for their health benefits and nutritional value. They have had an essential place as common food in history due to their abundance of minerals, especially electrolytes; vitamins, especially vitamins C and E; while various studies are ongoing revealing their phytochemical content, which has antioxidant capacity [2]. Therefore, regularly eating fruits and vegetables can reduce the risk of death related to these diseases. Most natural antioxidants convert lipid radicals into more stable products by breaking the chain. Antioxidants obtained from vegetables and fruits mainly have a phenolic structure, which may include vitamins, minerals, and polyphenols. Antioxidant minerals, such as iron, zinc, selenium, copper and manganese, act as cofactors for many antioxidant enzymes, the absence of which can certainly disrupt the activity of antioxidant enzymes. Their enzyme scavenging activity. The antioxidant capacity of different fruits is presented.

TYPES OF NATURAL ANTIOXIDANTS

Polyphenols, found in fruits and vegetables, are a group of low and high molecular weight compounds that have antioxidant properties that prevent lipid oxidation. Most of them are conjugates of mono and polysaccharides linked to one or more phenolic ring groups or may also occur as functional derivatives such as esters and methyl esters. This primary type of natural antioxidant can be obtained from teas, especially green and red teas, as well as fruits such as grapes. However, the polyphenols in tea are of greater importance than in fruits due to their bioavailability in the blood. About 15-20% of polyphenols are absorbed into the human bloodstream from their intake. This absorption is enhanced when no sugar molecules are attached to them. Therefore, tea is more likely to absorb polyphenols in fruit due to the high sugar content in fruit. Flavonoids, another important antioxidant content, are a subclass of polyphenols found abundantly in most foods, such as potatoes, wheat, tomatoes, soft fruits, peaches and almond. Anthocyanins are a subcategory of flavonoids found in berries and red wine. It is a potent antioxidant with reduced bioavailability compared to other flavonoids. Polyphenols show their antioxidant properties by preventing the oxidation of low-density lipoprotein (LDL), thereby preventing plaque formation. Certain types of polyphenols have also been shown to inhibit the oxidation of several important enzymes and thus maintain their normal activity. Carotenoids are another major class of plant antioxidants from fruits and vegetables after polyphenols. They are mainly found in root vegetables such as potatoes, carrots, papayas and apricots [3]. Of the vitamins obtained from fruits and vegetables, which act as antioxidants, vitamin C, also known as ascorbic acid, is a very powerful water-soluble antioxidant commonly found in fruits and vegetables like oranges, lemons and tomatoes. It is advisable to take fruits and vegetables that contain vitamin C in small doses rather than taking large amounts at once because less vitamin C is absorbed when taken in large amounts. Another vitamin with antioxidant properties is vitamin E, which is related to the tocopherol antioxidant family. It is a non-polar, fat-soluble vitamin found naturally in high-fat fruits and vegetables, such as olives, sunflowers, and nuts. Vitamin E has a higher bioavailability than vitamin C, this may be due to its fat solubility and can be further enhanced when taken with fatty foods.

Vegetable waste is generated during cultivation, industrial management, processing, storage and distribution. Over the past few decades, researchers have struggled to find a way to recycle this waste to provide therapeutic benefits. Vegetable and fruit waste includes peels, trimmings, skins, seeds, stalks and residues left over from juice and starch extraction or sugar processing. This waste accounts for about 25 to 30%. According to the study, the amount of phenol and ascorbic acid in these scalp wastes was higher in the pulp and in the unripe form than in the ripe form. Most fruit peels contain 2 to 27 times more antioxidants than their pulp. According to Someya et al., banana pulp has 232 mg/100 g of phenolic components, and this amount is only 25% of the amount found in banana peels. The peel of Cucumis sativus (cucumber) has been reported to be a good source of flavonoids, which are considered a potential antioxidant. Many bioactive substances can be recovered from these wastes for food processing in food processing and medicinal

preparations. A considerable amount of bioactive phytochemicals, with potent antioxidant properties, can be obtained from tomato waste, including carotenes, tocopherols, terpenes, sterols and polyphenols. These natural antioxidants obtained from food waste can be used to form functional foods or can be used as food additives. Many antioxidants, such as carotenoids, phenolics, vitamin C and fiber, are found in mango skins. These compounds have reported activity against many degenerative diseases, such as Alzheimer's disease, cataracts, cancer, and Parkinson's disease. Waste from the wine industry consists of degradable solids such as skins, stems and seeds, which are rich in antioxidants that have been shown to prevent many degenerative processes and have beneficial effects on health. strong. Pujol et al. reported that coffee waste from the coffee industry contains about 6% polyphenols and about 4% tannins [4].

MUSHROOM AS AN ANTIOXIDANTS

In the world of nutrition, mushrooms are the representative vegetable; however, they are not actually plants. They belong to the mushroom kingdom. Although not a vegetable, mushrooms provide essential supplements. Mushrooms are considered a healthy food with many uses, and are also a valuable source of medicinal herbs. Many edible mushrooms (mainly Basidiomycetes) are excellent sources of important nutrients, including carbohydrates, such as β-glucans; lipids; B vitamins, such as niacin, flavin and pyridoxine; phenolic compounds, such as tocopherols; organic acids, for example, malate ascorbate, fumarate and shikimate; monoterpenoids and diterpenoids; proteins, eg hydrophobins; and trace elements[5], e.g. selenium. These components are known to be responsible for the 10 immunomodulatory, antibacterial, antitumor, antihypertensive, hepatoprotective, and antioxidant activities of the fungus. The number of fungi on Earth is estimated at 140,000 but possibly only 10% (about 15,000 species) are known. Of the approximately 15,000 known species, 2,000 are safe for human use and about 650 of these have therapeutic properties. There are several fungi including Agaricus bisporus Lentinus edodes, Armillaria mellea, Auricularia auricula, Boletus edulis, Ganoderma applanatum, Grifola frondosa, Hypsizigus marmoreus, Pleurotus, Schizophyllum Commune, Termitomyces sp. And Tricholoma has antioxidant properties [6]. The antioxidant properties of mushrooms are mainly due to their phenolic compounds. Phenolic acids are the main phenolic constituents found in mushrooms. There are many types of phenolic compounds recognized in wild mushrooms, including cinnamic acid, protocatechuic, p-hydroxybenzoic, pcoumaric acid, gallic acid, vanillin, rutin and quercetin. Polysaccharides are one of the main components of mushrooms. In recent studies, it has been revealed that they contain antioxidant properties. The scavenging properties of polysaccharides are affected by chemical properties such as atomic weight, degree of branching, monosaccharide type and ratio of monosaccharides, intermolecular relationships of polysaccharides, and variability of polysaccharides. Among the monosaccharides, rhamnose is the most important determinant with regard to its fungicidal properties [7].The following mushrooms have antioxidants properties-1. Agaricus Bisporus 2. Armillaria mellea 3. Auricularia auricula 4. Bolepus edulis 5. Ganoderma lucidum.

EXTRACTION PROCESS OF NATURAL ANTIOXIDANTS

As mentioned, many natural antioxidants are contained in the plant matrix and their separation for later use is necessary. Antioxidants can be extracted from different parts of the plant such as leaves, roots, stems, fruits, seeds, and bark. The quality of natural extracts and their antioxidant capacity depends not only on the quality of the original source (e.g. geographical origin, nutritional and preservation aspects) but also on the technology. applied for extraction. To date, extraction processes have mainly been carried out at the laboratory scale... In addition, Solana and Mirofci investigated the scaling-up of supercritical fluid extraction of phenolic compounds and glucosinolates from arugula lettuce[8]. However, these newer technologies often have a higher investment cost, but the environmental impact is usually lower. Some examples of methods used to extract natural antioxidant compounds from different sources. Extraction efficiency and antioxidant capacity depend on the solvent, process conditions and extraction method used. These factors can affect the quantity and quality of antioxidants in the extract; for example due to decomposition and polymerization reactions. Efficient extraction is achieved when the maximum amount of bioactive compounds can be extracted with the lowest degree of compound degradation and the minimum amount of non-antioxidants, such as sugars and organic acids [9].There are majorly two techniques of Extraction:-

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A.Conventional Extraction Techniques

Solvent extraction (solid-liquid or liquid-liquid) involves the selection of a solvent and the use of heat and/or agitation. The solid-liquid extraction process is typically performed in a Soxhlet apparatus, where the plant material is placed with a condensing solvent. Advantages of using Soxhlet include, among other advantages, the reproducibility of bringing fresh solvent into contact with a solid matrix and no need for filtration at the end of the process. However, it has disadvantages, such as the need for a large amount of solvent, and therefore a concentration/evaporation process; no agitation during the process; and thermal decomposition of compounds, since this process is usually carried out at the boiling point of the solvent for a long time. When dealing with plant materials rich in a variety of phenolic compounds, the extraction yield depends on various factors, such as the type of solvent used (polarity), extraction temperature, time and solvent/vegetable ratio. The choice of solvent depends on the nature of the compounds it wants to extract, since extraction efficiency is affected by their solubility in the solvent used. The solvent-vegetable ratio must be optimized to use an appropriate solvent concentration that prevents its saturation with the extracted molecules during extraction. Since they can be attached to insoluble components, such as waxes, terpenes or fats, a preliminary solid-liquid extraction procedure may be required to remove phenolic and non-phenolic substances. unexpected. Different solvents were used, separately or in mixtures. , including ethanol, acetone, methanol, hexane and water. In the study by Peschel and Sánchez-Rabaneda, fruit and vegetable by-products (beets, apples, strawberries, pears, artichokes, asparagus, tomatoes, broccoli, cucumbers, chicory, chicory, yellow bars and pastels) were extracted using five solvents: water, methanol, ethanol, acetone and hexane. It was found that in general, the yield was higher due to one-step extraction with water and methanol compared with other methods. On the other hand, the extraction of anthocyanins and polyphenols from grapes and red and black currants was more efficient with ethanol and methanol than with water. In addition, Boulekbache-Makhlouf and Medouni studied different solvents to quantify the synthesis of phenolics, flavonoids, tannins and anthocyanins in eggplant skins. They concluded that methanol was the best solvent for anthocyanin extraction, mainly because they are polar molecules, and acetone was described as the best solvent for the quantification of other compounds. Fu and Tu studied the extraction of phenolic compounds and anthocyanins from sweet potato leaves using three solvents (water, ethanol and acetone). They reported that the extract with 70% ethanol yielded the extract with the highest total flavonoid and total anthocyanin content. However, acetone was the solvent that produced the extract with a higher total phenolic content. Although there is a lot of work in the literature focusing on extraction efficiency, it is still unclear which solvent is most effective for a particular 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[10].

B.Non Conventional Extraction Techniques which includes Supercritical Fluid Extraction, High Hydrostatic Pressure (HHP), Ultrasound Assisted Extraction(UAE), Microwave Assisted Extraction (MAE).

a. Supercritical Fluid Extraction SFE is an environmentally friendly process and an alternative to conventional organic solvent extraction, as it uses a supercritical state liquid as the solvent, avoiding the use of large amounts of water. Undesirable toxic solvents in the food industry. In addition, it is performed in the absence of light and oxygen, which reduces the decomposition of compounds. Carbon dioxide is the most common solvent used to obtain supercritical conditions, mainly due to its low toxicity, low cost, ease of separation from extracted solutes, compatibility with food products and the ability to use when low temperatures are required. Carbon dioxide SFE is an effective alternative to conventional solvent extraction methods, especially for the extraction of lipophilic plant materials, such as lipids, essential oils and aromatic compounds. The same is not true for more hydrophilic substances, such as phenolic compounds, alkaloids and glycoside compounds, which are poorly soluble in supercritical carbon dioxide. This process has been applied, for example, in the extraction of carotenoids from mango peel and phenolic compounds from apple pulp [11]. b. High Hydrostatic Pressure (HHP) and Pressurized Liquid Extraction(PLE) In HPP and PLE processes, pressure is applied to accelerate mass transfer between solid substrates and extraction solvent, leading to fast and efficient alternative methods for extraction of active compounds. However, high pressure can improve extraction efficiency but with higher investment cost. When HHP is applied, the material/solvent mixture is sealed in a package and placed in a

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container with a pressure transfer medium (e.g. water, hydrophilic and lipophilic organic solvents in different concentrations.). Pressure is applied, typically in the range of 100 to 1000 MPa, at controlled temperatures, including ambient temperature, which is an advantage where sensitive compounds are involved. heat. This method has been used successfully, for example, in the extraction of flavonoids and lycopene from tomato pulp and phenolic acids and flavonoids from watercress. Furthermore, BrionesLabarca and Plaza-Morales [106], demonstrated that HHP allows higher yields and shorter extraction times than other extraction methods (ultrasonic and conventional extraction) when It is applied to recover phenolic compounds and oils from papaya seeds. In the case of the PLE process, the material/solvent mixture is fed directly into the sealed vessel, then high pressure (3.3−20.3 MPa) and temperature (40−200 °C) are applied. , allowing for a fast extraction time (3− 20 min). Solvents under pressure remain liquid above their boiling point, allowing high-temperature extraction. There is an improvement in the solubility of compounds and the desorption kinetics of the substrates. This process has been used to extract a number of natural bioactive compounds, such as menthol, polyphenols from golden berries, carotenoids from carrot byproducts, and phenolic compounds from variety of plant materials (e.g. goji berry, feijoa bark, grape pulp). , used coffee grounds and olives)[12]. c. Ultrasound Assisted Extraction(UAE) UAE is a method in which ultrasound is applied to a solvent-solid mixture containing the target molecules. It is a process that combines mixing effects with the physical effects of ultrasound on raw materials (e.g. fragmentation, erosion, sonocapillary effects, ultrasonication, local shear stress and disintegration). of plant cell walls) increases the mass transfer rate, which may explain its better mining performance. In the long run, this reduces extraction time, solvent usage and energy consumption. In addition, ultrasound can also be applied in combination with other methods, such as soxhlet extraction, microwave extraction, supercritical fluid extraction, and extrusion. UAE has been used in the extraction of bioactive compounds, such as carotenes from pomegranate waste, phenolic compounds from blueberry pulp, and cooking oils from vegetable sources. This technology has also been used as a complementary technique to conventional techniques. Guandalini and Rodrigues used ultrasound to recover pectin, after extracting phenolic compounds from mango peels by conventional water-ethanol extraction, with the aim of valuing all remaining residues obtained [13]. d. Microwave Assisted Extraction (MAE) Using microwaves is another green extraction method, which is based on the direct impact on polar compounds. MAE offers rapid delivery of energy to a total volume of solvent and solid matrix with subsequent efficient and homogenous heating of both phases. It enables the reduction of the extraction time and solvent volumes, and can be performed in open or closed systems. In the latter case, the solvent and sample are contained in sealed vessels under a controlled temperature and pressure. The closed vessels allow the temperature of the solvent to rise above its boiling point, which decreases extraction time and subsequently increases extraction efficiency. As such, polar solvents, such as ethanol, methanol and water should be used. This process has been applied to recover antioxidants from a large number of plant[14].

STABILIZATION PROCESS

After extraction, natural antioxidants are susceptible to degradation during storage and when incorporated into food products, as they are very sensitive to environmental conditions (e.g. temperature, pH, light, oxygen and humidity). To increase their stability and avoid nutritional and functional losses, the rate of decomposition must be minimized. Ideally, the method should be simple, fast, and easily reproducible on an industrial scale at low cost. The most common techniques can be divided into chemical processes (e.g., coagulation or molecular immersion in cyclodextrin) and mechanical processes (e.g. spray drying, fluidized bed coating, cooling/ spray cooling, extrusion, emulsification and freeze drying). Stability is generally achieved when manufacturing capsule structures (from the nanometer to micrometer range), including the core and the wall material. The core of capsules consists of the ingredients to be protected, and the wall material—also denominated as the coating, shell, membrane, carrier or coat—is the external layer or layers that cover the core, made of food grade materials (e.g., polysaccharides, proteins and lipids) [15]. Beyond the protection of the bioactives against degradation reactions promoted by external factors, the encapsulation in the form of micro/nanoparticles for the food industry also enables easier handling of bioactive compounds that may be in another physical state (e.g., converting a liquid active compound into a powder); the prevention of evaporation and degradation of volatile active compounds, such as

essential oils, masking negative organoleptic properties such as color, flavor and odor of the natural antioxidants; the controlled release of the encapsulated materials at a specific time and place in the human body; and their immobilization in the food processing systems[16].

APPLICATION OF NATURAL ANTIOXIDANTS

A. Role of Antioxidants in Food Industries Cells are protected against oxidative stress by an interacting network of antioxidant enzymes. Superoxide released by processes such as oxidative phosphorylation is first converted to hydrogen peroxide and then reduced further into water. This detoxification pathway is the result of several enzymes, with superoxide dismutase catalyzing the first step, followed by catalase and various peroxidases that remove hydrogen peroxide. fats in marketed food products. As people's lifestyles and attitudes about food change, there is an increasing shift from convenience foods to the ready-to-eat category. For this, several potential health-protecting factors known as antioxidants are required.Antioxidants, both natural and synthetic, have wide applications in the food industry. as they are used as food additives in fats and oils to help prolong the shelf life and appearance of foods. many food products.Therefore, efforts are being made to reduce oxidation by fortifying antioxidant supplements into foods. Lipid oxidation is a major cause of deterioration in the quality of many natural and processed foods. It is generally undesirable in most foods because it leads to the development of rancid and potentially toxic reaction products. One of the most effective ways to delay lipid oxidation in foods is to incorporate antioxidants as preservatives. hydroxytoluene (BHT, E321) effectively inhibited oxidation. For example, chelating agents such as EDTA can bind metals reducing their contribution to oxidation [17]. The search for effective methods to delay oxidation in meat and meat products has led researchers to study natural antioxidants. Adding antioxidants to meat and meat products is known to be effective in metmyoglobin formation and lipid oxidation. These preservatives include plant phenols which are natural antioxidants like vitamins (ascorbic acid 20 [AA] and α-tocopherol (E306)), a variety of herbs and spices (rosemary, thyme, oregano, sage, basil, pepper, cloves, cinnamon, and nutmeg) and plant extracts (tea and grape seed) contain antioxidant components thereby conferring antioxidant properties to the compound [18]. As the use of synthetic antioxidants (such as butylated hydroxytoluene and butylated hydroxyanisole) to maintain the quality of ready-to-eat food products has become widespread, consumer concerns about safety have emerged. Their safety has prompted the food industry to look for natural antioxidants. Antioxidants obtained from plants have more functions in improving the shelf life of food products and promoting health than raw materials where antioxidants have been removed during processing. Therefore, current studies are being investigated on different technologies for the extraction and processing of plant extracts for use as antioxidant additives for the food industry. products [19]. B. Medical Application of Antioxidants Antioxidants play an important preventive role not only for undesirable changes in the taste and nutritional quality of foods, but also for tissue damage in various human diseases. They are effective in preventing degenerative diseases, such as various types of cancer, cardiovascular and neurological diseases, cataracts and dysfunction caused by oxidative stress. Chronic diseases such as arteriosclerosis and cancer, which are the leading causes of death in the Western world, are likely to be caused by lipid and free radical oxidation mechanisms. Antioxidants have been studied and reported to play a specific role in the treatment of these diseases. disease/disorder.Polyphenols are the most important compounds for the antioxidant properties of plant materials. Parts of medicinal plants are generally rich in phenolic compounds, such as flavonoids, phenolic acids, stilbens, tannins, coumarins, lignans, and lignins. These compounds have many biological effects, including antioxidant activity. Various studies performed to date have confirmed the role of antioxidants, namely lanthanides, selenium, flavonoids, lycopene and glutathione as anticancer compounds in biosynthetic chemistry. Recent developments in medicinal chemistry have become important in improving compound design, reducing toxic side effects, and understanding their mechanism of action. Antioxidants may play a role in many diseases. Over the past few decades, several epidemiological studies have shown that a diet rich in foods rich in natural antioxidants is associated with a reduced risk of coronary heart disease. Dietary and natural antioxidants found in foods and other biological materials have attracted considerable interest due to their presumed safety and nutritional effects. their potential health or treatment [20]. C. Industrial Application Antioxidants are often added to industrial products. A common use is as a stabilizer in fuels and

lubricants to prevent oxidation, and in gasoline to prevent polymerization that leads to the formation of engine deposits. They are widely used to prevent oxidative degradation of polymers such as rubbers, plastics and adhesives leading to loss of strength and flexibility of these materials. These compounds are added. foods to prolong the shelf life of products, mainly by preventing oxidation. unsaturated double bonds of fatty acids. In pharmaceuticals, antioxidants are added to improve the stability of therapeutic agents that are susceptible to chemical degradation by oxidation. Research and application development of plant extracts related to antioxidant activity in food processing requires results in terms of rich source of antioxidants, technological innovation methods extraction, application techniques with respective threshold levels, successive effects and regulatory aspects to improve their oxidative activity. the stability.

II. CONCLUSION

Over the past decade, an increasing interest has been observed in the discovery of natural ingredients for use in foods and food products. Researchers around the world are focusing on alternative sources other than synthetic sources, which are safer and more convenient as a food ingredient. Although no adverse reports have been observed in relation to synthetic antioxidant use, consumer interest in nature-friendly products is also compelling. In addition, synthetic antioxidants and preservatives in foods can lead to lipid peroxidation and reduce food taste and quality. The use of natural herbs, spices and plant materials has been practiced since ancient times and is still practiced in the preparation of traditional dishes as a preservative, aroma and flavoring agent. . This chapter is an attempt to examine the potential of various natural sources with reasonable antioxidant potential. The literature reports compiled here will be helpful in determining the importance of different natural sources based on their antioxidant capacity, active ingredients, and geographical availability. This chapter reveals that people may prioritize dietary habits based on the antioxidant potential and cost-effectiveness of the available source, as 70-80% of the world's population cannot afford supplements and modern medicine.

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