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Review Article

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The Role of Secondary Metabolites Obtained from Medicinal and Aromatic Plants in Our Lives

Abstract

Medicinal plants, which are used as drugs to prevent diseases, maintain health or cure diseases, take place in areas such as nutrition, cosmetics, body care, incense or religious ceremonies, while aromatic plants are used in different industrial areas to give fragrance and taste are used. Flora of Turkey has a rich plant diversity. Secondary metabolites such as essential oils, alkaloids, glycosides, saponins etc. are the most basic products of the industry directly or indirectly. The vast majority of medicinal and aromatic plants rich in secondary metabolites exhibit strong biological activity (antioxidant, antibacterial, etc.). Therefore, these secondary metabolites are widely used in the pharmaceutical industry. The most common and practical use of secondary metabolites, which are also used as natural insecticides, is in the form of herbal tea. In recent years, the more side effects of synthetic origin substances, especially the resistance of organisms against synthetic drugs used as antimicrobials, have increased the importance of natural herbal resources and medicinal plants carrying these substances. Therefore, there is no doubt that the demand for secondary metabolites, which are natural products, will increase in the future. Flora of Turkey is an important source for natural products which will be developed newly.

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INTRODUCTION

Medicinal and aromatic plants (MAPs) are plants that carry secondary metabolites such as alkaloids, terpenoids or phenolic substances with pharmacological activity in their organs such as leaves, stems, bark, flowers, fruits, seeds, roots, rhizomes, onions and tubers (Baydar, 2013). The demand for MAPs, which have been used as food, spices, tea, cosmetics and pharmaceutical raw materials for centuries, in the world markets is increasing day by day. Our country is located at the intersection of very important gene or origin centers (Mediterranean and Near East) of the world due to its geographical structure and different ecological conditions. It is also rich in habitat types as a natural result of its wide variety in topography, climate and geomorphology. Considering these factors, our country has a great economic potential in terms of medicinal and aromatic plants collected from nature and cultured. Turkey in 9753 shows the distribution of natural species.3 035 of these species are endemic. When subspecies taxa are added, there are 11 707 taxa of which 3 649 (31.82%) are endemic. (Güner et al., 2012). Today, MAPs are heavily consumed in order to prevent, cure and maintain health, which are used in many sectors such as food, medicine, cosmetics and spices (Do et al., 2014). While some of these plants are collected from nature, some of them are cultivated. In recent years, it has attracted an intense interest due to the positive effects of bioactive molecules obtained from MAPs and called secondary metabolites on human health. Photosynthesis and synthesis of secondary metabolites are known to distinguish plants from animals. Plants form components with different structures as a result of multiple synthesis reactions. Most of these substances formed in intracellular reactions are secondary metabolites. Secondary metabolites are chemical substances produced by plants that are at least as important as primary metabolites.

MAPs create raw materials for various scientific, technological and commercial applications by accumulating in their tissues economically important organic chemicals such as alkaloids, terpenes, phenolic compounds, glycosides. Phytochemicals, which are natural plant products, are used directly or indirectly in many industries. In this article, it is aimed to give information about secondary metabolites and usage areas.

SECONDARY METABOLITES

Plant chemicals are generally divided into primary and secondary metabolites

(protein and nucleic acids are outside of this classification). Primary metabolites (carbohydrates, fats, proteins, etc.) are quite common in nature and are quite abundant in the seeds and vegetative tissues of higher plants and are necessary for the physiological development of the plant because of their basic role in cell metabolism (Cowan, 1999; Theis and Lerdau, 2003). Apart from primary metabolites, there are small molecule secondary (secondary) metabolites such as alkaloids, essential oils, phenols, glycosides, steroids, saponins, flavanoids, coloring agents and resins, which are not absolutely necessary for the vitality of plants and are sometimes immeasurable.

These secondary metabolites are classified into three basic groups as alkaloids, terpenoids and phenols. Alkaloids are substances of basic character, which are obtained from plants, generally show strong physiological and pharmacodynamic activity, carry one or more nitrogen in the ring. Like other secondary metabolites, alkaloids are compounds that play a role in defense against herbivores and pathogens in plants. Alkaloids are usually found in certain organs of plants such as roots, bark, leaves, fruits and seeds. Approximately 12 000 known for their potential biological activity is used as alkaloid, pharmaceutical, stimulant, narcotic and poison (Zulak et al., 2006). Terpenoids are secondary metabolites in hydrocarbon structure. Terpenoids consist of isoprene units; they are classified as monoterpenes, sesquiterpenes, diterpenes, triterpenes and tetraterpenes. Monoterpenes are the most important odor molecules secreted in aromatic plants. Most terpenoids, which are diverse in their structures, are biologically active compounds. They are used in the treatment of many diseases around the world. On the other hand, terpenoids have important functions in fields such as pharmaceuticals, food, cosmetics, etc. Phenol is a chemical substance bonded to an aromatic hydrocarbon group by a hydroxyl group. Phenolic acids, flavanoids, anthocyanins and tannins are the most common phenols (Lattanzio, 2013). Flavanoids protect cells against antiradicals as powerful antioxidants (Pereira et al., 2009).

USAGE AREAS OF PLANT SECONDARY METABOLITES

Secondary metabolites obtained from various organs of plants have different uses.

Pharmaceutical products

Secondary metabolites obtained from plants are industrially converted into drugs.

Herbal products continue to play an important role in the discovery and development of medicines today as in the past (Newman and Cragg, 2012). For example, after clinical trials demonstrated the memory-enhancing effect of ginkgo (*Ginkgo biloba*), the aphrodisiac effect of ginsenging (*Ginseng panax*), the antidepressant effect of centaury (*Hypericum perforatum*), and the immune system enhancing effect of echinacea (*Echinecea purpurea*), the use of these herbs has increased greatly. Now widely used aspirin active ingredient is salicylic acid for the first-time willow tree (*Salix alba*) bark, again quinine used as antimalarials first cinchona tree (*Cinchona officinalis*) was isolated from the bark. Secondary metabolites that stand out in cancer treatment have gained great importance. For example, from the alkaloid of ellipticin obtained from the yew tree (*Taxus brevifolia*), Taxol®, and from the camptothesin alkaloid obtained from the camptothesa tree (*Camptotheca accuminate*), commercially available cancer drugs have been produced under the name Topotecan ® (Newman and Cragg, 2012; Baydar, 2013). Today, many compounds obtained from plants are in the use of modern medicine. For example; Sennoside (laxative) isolated from *Senna alexandrina* leaves, eucalyptol (expectorant) obtained from *Eucalyptus globulus* leaves and thymol (antiseptic) obtained from *Thymus vulgaris* leaves are used for medical purposes (Rungsung et al., 2015). In this way, a large number of compounds obtained from plants are used for medicinal purposes.

Antibiotics

Antibiotics are molecules that kill or stop the growth of microorganisms, including bacteria and fungi (Kukula, 2019). Antibiotics are among the most used drugs all over the world. Antibiotics are used incorrectly and excessively in developing countries (Hart, 1998). As a result of unconscious and unnecessary use of antibiotics, both environmental problems and health problems occur in living beings, especially humans, through the food chain (Topal et al., 2015). Many of the secondary metabolites synthesized by plants are considered natural antibiotics since they have antibacterial effects. While synthetic antibiotics contain only one active substance, an herbal antibiotic contains dozens, sometimes even hundreds of effective bioactive substances. For example, while penicillin only carries penicillin, garlic, a powerful antibiotic,

carries dozens of antimicrobial agents, especially allicin. There are hundreds of medicinal herbs such as sage (*Salvia* sp.), rosemary (*Rosmarinus officinalis*), laurel (*Laurus nobilis*), echinacea (*Echinacea purpurea*), basil (*Ocimum basilicum*), clove (*Dianthus caryophyllus*), thyme (*Thymus* sp.), lavender (*Lavandula officinalis*), melissa (*Melissa officinalis*), mint (*Mentha* sp.), licorice (*Glycyrrhiza glabra*), eucalyptus (*Eucalyptus* sp.), fennel (*Foeniculum vulgare*), cinnamon (*Cinnamomum verum*), chamomile (*Matricaria recutita*), and ginger (*Zingiber officinale*) which are found to have strong antibiotic effects (Mimica-Dukić and Bažin, 2007; Al-Mariri and Safi, 2013; İlkimen and Gülbandılar, 2018).

Antioxidants

Free radicals that occur during normal body functions damage cells and the immune system and accelerate aging. Antioxidants, on the other hand, bind free radicals to themselves or neutralize them, minimizing possible damage and thus delaying aging (anti-aging) (Panchawat et al., 2010). Under normal conditions, the damage caused by oxygen radicals is kept under control by the organism's effective antioxidant systems. However, in pathological conditions, the oxidant and antioxidant balance changes. Studies have shown that antioxidants prevent cell death caused by oxidative stress (Parihar and Hemnani, 2003; Deveci et al., 2016). Organic and inorganic substances such as beta-carotene, vitamins C, E, lycopene, coenzyme Q-10, selenium, zinc and manganese are the most commonly used antioxidants today. On the other hand, most of the medicinal and aromatic herbs rich in secondary metabolites have strong antioxidant effects. For example, aromatic plants belonging to the Lamiaceae family, especially rosemary (*Rosmarinus officinalis*), mint (*Mentha* sp.), sage (*Salvia officinalis*), mountain grass (*Sideritis* sp.), lemon balm (*Melissa officinalis*) and thyme species (*Origanum* sp., *Satureja* sp., *Thymbra* sp. and *Thymus* sp.) which have high antioxidant properties (Öztürk et al., 2002 a,b; Çoban and Patır, 2010; Deveci et al., 2016)

Herbal teas

One of the most economical and practical uses of secondary metabolites is herbal teas prepared as infusion or decoction. According to the European pharmacopoeia, "herbal teas are orally used aqueous preparations prepared by maceration, decoction and infusion of one or more drogs, they are prepared just before

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use." (European Pharmacopoeia, 2013). In recent years, herbal teas have been widely used to benefit from their antioxidant and antibiotic properties and medicinal value. Herbal teas are produced purely from a single plant or as a combination of more than one herb with different active ingredients. The characteristic taste, odor and stimulating effect of common beverages such as coffee, cocoa, tea and cola is due to the secondary metabolites (mainly caffeine) that these products have. Today, although most of the herbal teas are consumed for their pleasant taste, some herbal teas are used for health protection due to their antioxidant effects (Moraes-de-Souza et al., 2008; Zhao et al., 2013). However, we mostly use herbal teas to relieve our ailments such as colds, fatigue and indigestion (Toker et al., 2015). Today, tea is made from many herbal materials. In our country, the tea of many medicinal plants such as sage, linden, mint, fennel, chamomile, echinacea, rosehip, thyme, anise, basil is produced (Akgül and Ünver, 2001).

Insecticides

Insecticides derived from plants have great potential for the natural control of insect pests. Due to the increased resistance of insects to chemical insecticides, they have increased the importance of MAPs as potential insecticides. Extracts obtained from plants have been used as an insecticide since ancient times. It is known that more than 2000 plant species have natural insecticide properties. For example, the pyrethrin substance found in the flowers of the pyrethrum (*Chrysanthemum cinerariaefolium*) plant has been used as an insecticide since the 19th century. Another natural insecticide that has gained widespread importance today is azadiractine, which is obtained from the fruits of the neem tree (*Azadirachta indica*). Also, the essential oil rich in beta-asaron, obtained from the spinach (*Acorus calamus*) plant, shows insecticide effect by causing infertility in insects (Ratton, 2010). Digitoxin from *Digitalis purpurea*, thymol from *Thymus vulgaris*, ajugarin I from *Ajuga remota* and methyl salicylate from *Gaultheria procumbens* are examples of natural insects (Adeyemi, 2010). Also, sage (*Salvia* sp.), anise (*Pimpinella anisum*), rosemary (*Rosmarinus officinalis*), dill (*Anethum graveolens*), basil (*Ocimum basilicum*), thyme (*Origanum* sp.), cumin (*Cuminum cyminum*), mint (*Mentha* sp.) and the essential oils of many aromatic plants such as wormwood (*Artemisia* sp.) create a fumigant effect against many

storage pests such as *Sitophillus* and *Bruchus*, thereby removing and lethal effects (Baydar, 2013).

CONCLUSION

MAPs accumulate organic chemicals such as economically important alkaloids, phenolic compounds, glycosides, and form raw materials for various scientific, technological and commercial applications. In other words, phytochemicals, which are natural plant products, are used directly or indirectly in many industries. It is known that the trade of these secondary products increases day by day. Research on the discovery of new plant-based chemicals is still ongoing and it is highly likely that it will continue in the future. Our country has an important potential for many secondary metabolites with its flora richness.

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