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Production of Bioactive Compounds by Aromatic Species

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Herbs and spices, which are aromatic plants, have been used for food preservation and traditional medicine since ancient times. Oregano, rosemary, sage, anise, basil, and many other well-known aromatic herbs have their roots in the Mediterranean. Antimicrobial, antioxidant, antiparasitic, antiprotozoal, antifungal, and anti-inflammatory properties have all been observed in these plants because of the high concentration of polyphenolic compounds they contain. Increased interest in these plants and their derivatives can be attributed to the fact that they are all-natural, environmentally friendly, and widely acknowledged to be safe. This means that aromatic plants and their extracts could play a role in the next generation of substances used to improve human and animal health through diet and supplementation. The goal of this article is to provide a synopsis of the research on aromatic plants' in vivo and in vitro applications.

Keywords: Aromatic Plants, Aromatherapy Oils, Antioxidant

Introduction

Aromatic plants, their extracts, and essential oils are increasingly being used as functional ingredients in the pharmaceutical, food, and feed industries [1]. This is due in part to the growing interest of consumers in substances of natural origin and the increasing concern surrounding potentially harmful synthetic additives. The need for efficient, secure, and reasonably priced substances is great in these sectors.

With a well-established mechanism of action and tangible advantages. There is a great deal of potential for plant-derived components to meet such needs. Despite the fact that there is still a lack of knowledge, particularly concerning the consistency of in vivo trial results and mechanisms of action of various components within the aromatic plants [2], they could be applied as new-generation compounds for human and animal health and nutrition. Consider, too, that when animal health is better, food quality and safety are enhanced for the benefit of consumers.

For at least 5,000 years B.C.E., people in the Middle East have been taking advantage of the medicinal and flavor-enhancing qualities of aromatic plants (herbs and spices)[3][4][5] [6], [7]. WHO reports that 80% of the world's population, especially in developing countries, continues to use medicines derived from plants (WHO). Plant-based feed additives are a great way to raise animal productivity and improve the quality of feed and byproducts (also called phytogenics, probiotics, and botanicals). Aromatic herbs, plant extracts, and essential oils have been extensive study due to their possible superiority to antibiotics as a natural growth stimulator. You can use them with confidence because they leave no sticky aftertaste and are considered GRAS (safe for human consumption) [8][9][10].

There is increased interest in using herbs and spices in animal nutrition as an alternative to antibiotics and ionophore anticoccidials since the prohibition on antibiotic feed additives

inside European Union countries in 2006 and efforts to limit their usage outside of Europe[11][12].

All around the world, you may find herbs and spices like rosemary, oregano, sage, thyme, peppermint, and garlic growing in the wild or in gardens. Polyphenols, quinines, flavonols/flavonoids, alkaloids, polypeptides, and their oxygen-substituted derivatives are among the list of these substances. [13][14][15] There are cases where two or more of these substances work together to increase one another's bioactivity [16][17][18]. Antioxidant and antiseptic properties, two examples of the therapeutic potential of bioactive compounds, have been documented [19][20]. As a result, they might be helpful in the prevention or treatment of a wide range of illnesses and diseases, such as cancer, cardiovascular disease, gastrointestinal or inflammatory issues, and respiratory disorders. The bioactive elements in aromatic plants can shield the organism from oxidative stress damage by quenching singlet oxygen and activating cytochrome or other enzymes[21] [22][23]. Additionally, some herbs and spices have been shown to delay the onset of off-flavor and prevent oxidative rancidity[16] [24][25]. In addition, they contain antimicrobial compounds that help slow down the growth of bacteria and other microorganisms on foods [26].

Related Studies

Aromatic plants contain essential oils, which have a powerful, pungent smell (or volatile or ethereal oils). They can be found in the stems, leaves, bark, roots, flowers, buds, seeds, fruits, and wood of a plant[18] [11] [27]. Essential oil secondary metabolites, such phenylpropene and low boiling point terpene mixes, are notoriously difficult to understand. The Asteraceae (Compositae), Lamiaceae (Labiateae), and Apiaceae (Umbelliferae) families produce the vast majority of essential oils.

Gas chromatography and mass spectrometry are two procedures that can be used to thoroughly evaluate the volatile components of the oils. Terpenoids such as linalool, geraniol, borneol, menthol, thujanol, citronellal, and -terpineol, and phenols such as thymol, carvacrol, eugenol, and guaiacol, are also included among the many low molecular weight aliphatic hydrocarbons.[9]

Traditionally, oils have been extracted through steam distillation; however, in recent years, supercritical carbon dioxide extraction has gained popularity [28] [29] [30]. Essential oils are cytotoxic, toxic to living cells, and non-genotoxic, depending on the type and concentration. Phenols, aldehydes, and alcohols are largely responsible for essential oils' cytotoxic activity[31][32][33].

Due to its potential to be used in the treatment of human and animal diseases, the control of parasites, and the preservation of agricultural and marine goods, cytotoxic activity is the subject of substantial research[34] [35] [36]. Long recognised to possess antimicrobial capabilities against a wide range of pathogens, including bacteria, viruses, fungi, protozoa, parasites, and insects, essential oils and other parts of aromatic plants are known to exist. Certain essential oils have even been demonstrated to have hypolipidemic, antioxidant, digestive stimulant, and antioxygenic effects in addition to their many other uses, which include eliminating odours and lowering ammonia levels[37] [38].

Essential oils are extracted from over 3,000 different plants, with only about 300 being used in the food and fragrance industries [39]. Oils are used for their medicinal properties in the pharmaceutical industry, while their aesthetic value is put to use in the cosmetic industry via fragrances, skin and hair care products, aromatherapy, and other means. [29]

In addition to their aromatic qualities, aromatic plants also have antimicrobial properties [40][41], which are at least in part due to the essential oils they contain. We are aware that essential oils can build up in the lipid bilayer of mitochondria and bacterial cell membranes, changing the structures and making them more permeable because of their hydrophobicity. [42][43].

One antimicrobial mechanism of several essential oils is the disruption of cell homeostasis, which in turn causes growth inhibition and cell death[44][45] [46]. On the other hand, it has been postulated that the antibacterial action is due to the chemical structure itself, namely the presence of a functional hydroxyl (-OH) group and the aromaticity[47] [48][49].

In studies assessing essential oils' antibacterial efficacy against Gram-negative bacteria, promising results have been found. Essential oils have only been evaluated topically, meaning they have only been applied to the skin or mucous membranes[50].

Furthermore, the safety of essential oils when taken orally is not well understood [42]. Natural antimicrobial substances like those found in essential oils may one day be put to use as preservatives in the food industry to keep perishable items fresher for longer and reduce the frequency with which items go bad. Essential oils may also mitigate some of the harm brought on by chemical preservatives [49].

The majority of specialists concur that secondary metabolites included in essential oils and phenolic compounds (those having a hydroxyl group attached to a phenyl ring) are the most effective antibacterial agents. [51][52]. For instance, eugenol (a phenylpropene) and the monoterpenes carvacrol and thymol are examples of these compounds. Essential oils include a wide variety of antibacterial secondary metabolites, many of which are not phenolic. P-cymene and -terpinene, two monoterpenes, have been shown to have weaker antibacterial activity than phenolic monoterpenes, according to various studies[53]. Cinnamaldehyde, a non-phenolic phenylpropene, has been reported to exhibit potent antibacterial properties in other studies. [54]

Essential oils can vary in their chemical composition depending on a number of factors, such as the plant's natural origin, environmental and genetic factors, species and subspecies, geographical location, collecting season, plant portion used, and isolation procedure. [55].Research has shown that some aromatic plants' essential oils and extracts can encourage the growth of particular microorganisms. Because of their established capacity to increase the amount of advantageous bacteria already present in the gut, notably Lactobacillus and Bifidobacterium, prebiotics have been linked to positive health effects. Few in vivo research have looked at the prebiotic effects of aromatic plants. They have, however, been employed in ruminants to regulate rumen metabolism. [56].

Results

Natural antioxidants such as eugenol, thymol, and carvacrol can be found in aromatic herbs and the essential oils they produce. While glycosides are the more common form of polyphenols, aglycon structures—specifically catechol in aglycons—are credited with their bioactivity [57][58]. These chemicals' potent redox properties and chemical structure are thought to be the cause of their antioxidant action since they can quench singlet and triplet oxygen by delocalizing or dissolving peroxides. Phenolic antioxidants can decrease the progression of numerous oxidative stress-related ailments, including as cancer, diabetes, Alzheimer's, and cardiovascular diseases. The aforementioned features are related with its good health functions. Plant phenols have also been demonstrated to exhibit antioxidant activity in vitro, which means they may snuff out chain-crushing peroxyl radicals and avert the oxidation of lipids. Consequently, they can partially replace the use of -tocopheryl acetate or preservatives and protect highly unsaturated lipids in feed from oxidative destruction. Lipid oxidation, which produces reactive oxygen species (ROS) and off-flavors from polyunsaturated fatty acids, is one of the main issues limiting product quality and acceptability in the food sector[59].

Lipid metabolism may also be influenced by the presence of essential oils, which have been shown to alter the levels of polyunsaturated fatty acids and the antioxidant enzymes superoxide dismutase and glutathione peroxidase in animal tissues[60]. Therefore, despite being overlooked as nutrients, flavonoids are crucial substances in the diet.

In addition to their antioxidant properties, flavonoids (especially those with multiple hydroxyl groups) may play a role as pro-oxidants [61]. Subsequent to crossing the inner cell membrane, flavonoids are vulnerable to oxidation by reactive oxygen species (ROS), which can then convert them into pro-oxidants that can damage lipids, proteins, and DNA. By causing late apoptosis or necrosis in damaged cells, this mechanism can serve a "protective" function by reducing the number of mutants that are created.

In addition to the numerous in vitro studies that have already looked at the biological activities of herbs and spices, there have been several human studies that look at their advantageous effects when consumed as dietary supplements[62]. Anethole (the primary compound), pseudo isoeugenol, coumarins, scopoletin, umbelliferon, estrous, terpene hydrocarbons, polyenes, and polyacetylenes are just some of the bioactive compounds found in anise. Broiler chickens' productivity increased when fed a feed supplement containing 0.5% powdered garlic (Allium sativum). Allicin, the key bioactive compound in garlic, has impressive antimicrobial activity[63]. Furthermore, the performance of broilers was enhanced when cinnamon extracts or cinnamon essential oil were added to their diets. Six distinct plant essential oils, including oregano, laurel, sage, myrtle, fennel, and citrus, were proven to boost egg production in laying hens.

More research is needed because many other fragrant herbs may also help chickens perform better.

Members of the genus Eimeria are responsible for the protozoan disease coccidiosis, which is most frequently linked to the poultry business. Anticoccidial medications and, to a lesser extent, immunisations are the main ways that coccidiosis, a serious threat to human health and welfare, is controlled. Herbs and spices, as well as other dietary additions, may mitigate the harmful effects in birds with avian coccidiosis[64]. Dried Artemisia annual leaves have been shown by Allen et al. [65] to prevent caecal lesions in chickens brought on by Eimeria tenella infection. Since European Union governments plan to ban the use of chemical anticoccidials in livestock diet as of 2012, this research takes on an even greater significance.

The ability of many plants in the Labiatae family to act as antioxidants has been thoroughly investigated. Broiler beef products can be made more oxidatively stable by adding extracts of rosemary, sage, or oregano essential oil before being refrigerated or frozen for up to 9 months at 20°C. When dehydrated oregano and -tocopheryl acetate were combined to boost antioxidant activity in broiler diets, the result was greater than either supplement acting alone[65]. When added to hen egg yolks, the antioxidative properties of saffron, oregano, and rosemary were found to be modest, comparable to those of -tocopheryl acetate.

The antioxidants contained in aromatic plant extracts and essential oils, such as the phenolic isomers thymol and carvacrol, may have contributed to the improved oxidative stability of poultry meat products and egg yolks.

Aromatic herb diets for rabbits have been the subject of some research. The use of dried oregano in a rabbit's diet was shown to improve its performance[66][67]. Oregano and sage extracts were found to have positive effects on both rabbit health and the amino acid profile of their carcasses. Results from previous studies indicated that the antioxidative capacity of both raw and thermally treated carcasses was significantly increased by oregano essential oil while being stored in the refrigerator. Also, there was no sign of microbial growth in refrigerated rabbit corpses that had been given a diet containing oregano essential oil. In comparison to the controls, these carcasses exhibited significantly less sliminess and odour. It's likely that the antioxidant and antibacterial benefits seen were caused by components of the oregano essential oil entering the bloodstream and then being distributed throughout the body and retained in tissues[68][69].

It is not possible to prove the bioavailability of any of these components without first developing an analytical method for detecting and quantifying them at low concentrations in

tissues. Despite the fact that oils are used to manipulate ruminal metabolism to promote feed efficiency and animal output, there is currently a lack of evidence for the antibacterial effect of oils in ruminants. In vitro batch culture studies of essential oils and their constituents have demonstrated the ability to modify microbial communities, which may enhance ruminant nitrogen and/or energy utilization. These effects of essential oils are only seen at very high concentrations, and they may also decrease the total synthesis of volatile fatty acids by slowing ruminal fermentation. Yet, the microbial population of the rumen modifies after being exposed for a period. Due to their high bactericidal effect against harmful bacteria like Escherichia coli and Salmonella spp., aromatic plant research in rumen nutrition has the potential to increase animal productivity and health while also being environmentally benign.

Conclusions

In the food supplement, animal feed, pharmaceutical, and personal care product industries, aromatic plants, plant extracts, and essential oils may find use. To obtain pertinent information from the study of aromatic plants, it is required to standardize extraction methods and extract composition. The effectiveness of extracts should be confirmed by studies using standardized extracts before moving on to in vivo experimental research. In that, we can meet the needs of the public for food that is healthy, safe, and of high quality without resorting to artificial means.

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