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Antimicrobial and antioxidant activity of tomato leaves

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Abstract

Tomatoes are the primary dietary source of antioxidant lycopene, which has been related to multiple health advantages, including a decreased risk of cardiac failure and cancer. They are also a wonderful source of vitamin C, potassium, folate and vitamin K. Tomatoes may also come in a number of colors, including yellow, orange, green and purple, when matured. The byproducts of tomato plant have antibacterial and antioxidant properties. The leaf extracts contain flavonoids, chlorophyll, carotenoids, and total phenolic contents, having antioxidant activity. Extract was found to inhibit the growth of pathogens such as *E. coli*, *Salmonella, Typhimurium, Staphylococcus aureus*, and *Listeria ivanovii.* Tomato plant shows better potential as source of various bioactive compounds, antioxidants, and antimicrobials hence can protect against cancer, maintain healthy blood pressure, and reduce blood glucose in people with diabetes. Tomatoes contain key carotenoids such as lutein and lycopene. These can protect the eye against light-induced damage, help reducing cardiovascular disease too. Antioxidant activity of lycopene can delay the death of bone cells, improve bone structures and help maintain the bones safe and solid. The extracts derived from the tomato leaves can possibly be used as antimicrobial therapeutics in future, thus overcoming the issue of antimicrobial resistance due to antibiotics use.

Introduction

The tomato is the edible, often red, berry of the plant *Solanum lycopersicum*, commonly known as a tomato plant. The species originated in western South America and Central America. While tomatoes are fruits botanically classified as berries, they are commonly used as a vegetable ingredient or side dish. The plant comes under the family Solanaceae of order Solanales and kingdom Plantae. Tomato (*Solanum lycopersicum*) is a plant widely studied, whereas, only a few experiments have focused on tomato leaves. Despite being considered a byproduct of tomato processing, this plant material includes many bioactive metabolites, including alkaloids, phenolics such as hydroxycinnamic acids, and flavonoids. They do have various pharmacological and metabolic roles in humans [1].Flavonoids are unique metabolites having complex structure, non-volatile compounds, including chalcones, flavanones, flavonols, and anthocyanins. Flavonols, a flavonoid group, include kaempferol, quercetin, and myricetin. Flavonols are important radical scavengers in lipid oxidation reactions and possible chain breaking antioxidants [2]. The plants of Solanaceae family are having rich source of secondary

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metabolite steroidal alkaloids. In tomatoes, these compounds have a distinctive C27 cholestane backbone with a 22S or 25S oxa-azaspirodecane (spirosolane) framework. Tomatine is the primary alkaloid. This is composed of aglycone tomatidine and a trace of tetrasaccharides containing d-galactose, two d-glucose groups, and d-xylose. Tomato steroidal alkaloids have numerous biological functions including antiviral, antifungal, antibacterial, anti-inflammatory, reducing cholesterol, and Immunode ficiencies [3].Natural-product users and experts have paid attention to antioxidant compounds because of their pharmacological effects. Antioxidants can reduce oxidative stress resulting from reactive oxygen species. Natural antioxidant materials for use as pharmaceutical products and food additives are growing gradually. Phytochemicals such as polyphenols and carotenoids are essential with numerous biological effects such as antioxidant, antimutagenic, anticarcinogenic, and cytoprotective activities due to their contributions to human health [4]. Tomato fruit's phenolic content has been associated with its antioxidant ability. Such compounds also inhibit oxidative changes in cells by reducing the amount of free radicals, and epidemiological studies indicate a strong link between tomatoes ' antioxidant potential and a reduced risk of developing cardiovascular disease and cancer [5,6].At present, the trend in the agribusiness sector is to restore, analyze, and find suitable uses for all its by-products such as peels, nuts, roots, and leaves. Tomato crop by-products contain bioactive substances that may be possible sources of antimicrobial, antiviral, and antioxidant compounds, thereby making them economic importance in the food industry. In this context, it was investigated that the composition (steroidal alkaloids, total flavonoids, phenols, carotenoids, and chlorophyll) and the antioxidant and antimicrobial capacities of extracts from tomato leaves, which are found to be useful in selecting materials for the production of bioactive compounds and nutraceuticals.

Why Tomato Leaves?

Among the ketone extracts, tomato leaves had a lower minimum inhibitory concentration (MIC) than other tomato elements. The ketone extract from tomato leaves was thus found to have antimicrobial substances. The ketone extract from tomato leaves suppressed mycelial growth of *Fusarium oxysporum f. sp. lycopersici*, *Glomerella cingulata*, and *Rhizoctonia solani*. Studies have indicated that non-edible elements of the tomato contain good amount of antimicrobial compounds than edible elements. Tomato leaves are rich source of antimicrobial metabolites like chlorogenic acid, caffeic acid, vanillic acid, β-phellandrene, sabinene, α-terpinene, dehydrotomatine, and α-tomatine than tomato fruits. The leaf extracts from tomato plant showed the best flavonoids, chlorophyll content, carotenoids, and total phenolic contents and the highest inhibitor activity determined before [7]. Some reports have shown that tomato fruit extracts exhibit antimicrobial and antineoplastic properties. The phenoplast content of tomato fruits are correlative with their inhibition capability. These compounds

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additionally stop oxidative changes in cells by reducing the degree of free radical production. Additionally, tomato byproducts, seeds, represent a beautiful supply of fiber that also shows antimicrobial activities. Highest concentrations of tomatine were found in senescent leaves, followed by the stems, fresh leaves, calyxes, green fruits, and finally, the roots (which had the lowest concentrations). The acetonic extract from tomato leaves contain more diverse biochemicals (including antimicrobial compounds) than the solvent extracts of other tomato parts. Therefore, the acetonic extract from tomato leaves could be most useful as an antimicrobial agent. The acetonic extract from tomato leaves showed antimicrobial activity against different type of pathogens [8].

Significance

An inhibitor is generally outlined as any substance that delays or inhibits aerobic damage to a target molecule. Inhibitor compounds like phenolic resin acids, polyphenols and flavonoids scavenge free radicals comparable to peroxide, hydroperoxide or lipoid peroxyl and so inhibit the aerobic mechanisms that result in chronic diseases. The therapeutic effects of edible/medicinal plants were shown to be related to their chemical constituents. The natural compounds possess antimicrobial, antiulcer, medicament, anticancer, spasmolytic, antiviral, antibacterial and analgesic activity. Prevention of food spoilage and gastrointestinal disorder pathogens is sometimes achieved by use of chemical preservatives that have negative impacts including: human health hazards, chemical residues in food chains and acquisition of microorganism resistance to the used chemicals. Hence, the requirement to seek out a doubtless effective, healthy, safer and natural compound is highly essential in present scenario. Plant extracts are accustomed for management of gastrointestinal disorders and to preserve foodstuff due to their antimicrobial activity against several bacteria. Currently, the trend within the agriculture sector is to recover, evaluate, and realize higher uses for all the byproducts like peels, seeds, stems, and leaves of plants [9]. The antimicrobial activity of acetone, hexane, dichloro-methane, and methanol extracts from leaves, stems, immature green fruits, and red fruits of tomato plants was examined against six phytopathogens. The potential of tomato leaves was better with activity against R. solani and other fungal phytopathogens. Extracts from tomato leaves including antimicrobial compounds could give a brand new lead within the pursuit of recent biological sources of agrochemical candidates. Tomato crop byproducts contain bioactive substances that might be potential sources of antimicrobial, antiviral, and inhibitor compounds, giving them a lead within the food trade. Tomato plants additionally possess bioactive elements with medicinal and biological process properties.

Antibacterial Activity

Leaves of tomato plants (*Lycopersicon esculentum*) were obtained from various sources. All the extractions were performed in triplicate to accurately measure the total phenoplast, flavonoids,

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pigment, antioxidant, and antimicrobials [10]. *Escherichia coli*, *Staphylococcus aureus* etc. are some of the pathogens whose growth is inhibited by the leave extract of tomato. As compared to other parts of the plant leaf extract exhibits higher antibacterial property. This is concluded by the presence of total phenolic content. Thus, the higher concentration of phenolic content in extract indicates more antibacterial activity [11]. It was observed high polyphenol levels contributed positively to antimicrobial activity against *E. Coli* and also evaluated the effects of *Pseudomonas syringae* on the phenolic extracts of tomato leaves and found that the rise in the amount of the phenolic compound is influenced by the degree of microbial contamination and serves as a defense mechanism when the leaves are targeted by microbes. Some authors have identified that hydroxyl groups of polyphenols trigger inhibitory action in microorganisms, and these groups may interact with the bacterial cell membrane to disrupt the composition of the membrane and cause the loss of cellular components. Alternatively, it has been stated that these OH groups can act in the active enzyme site and disrupt the microorganism's metabolic processes. In fact, some studies have shown that the OH group's location in the aromatic ring of polyphenols as well as the length of the saturated side chain may also improve antimicrobial activity [12]. Furthermore, the aldehyde structure of certain phenolic compounds is associated with the double carbon-carbon bond, which has strong electronegativity and will potentially interfere with the movement of proteins and nucleic acids and increase its antimicrobial activity [13].

The presence of glycoalkaloids may increase the vulnerability of the assessed strains. Previous reports have shown that tomatine has an inhibitory effect and that tomatidine is bacteriostatic against *S. Aureus*. While steroidal alkaloids represent just 0.5 percent in leaf extracts and total phenols represent 14 percent, such results with phenolic compounds do not discard a synergistic impact. Some authors have stated that tomatidine extracted from the tomato plant has the capacity to function synergistically and potentiate the action of aminoglycoside antibiotics, and that it plays an important role against pathogens like *E. coli* reported that tomatidine's antimicrobial activity could be associated with the carbohydrate side chain structure and the existence of the glycoalkaloid aglycone moiety [14, 15]. The spiroaminoketal fraction of tomatidine has also been documented to be essential for antimicrobial activity. The tests of MICs revealed that the extracts of tomato plants exerted various degrees of growth inhibition against the bacterial strains born in fruit. The leaf extracts were usually found to have the highest antibacterial activity and MIC importance. The extracts derived from the leaves can be used possibly for antimicrobial preservatives for use in medicine or in the pharmaceutical industry. Antimicrobial activity of tomato leaves was observed which can be further used for the preparation of extract or pure compound possessing activity against *Rhizoctonia solani* and many other fungal phytopathogens.

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Antioxidant Activity

Antioxidants are compounds that inhibit oxidation. Oxidation is a chemical reaction which will produce free radicals, thereby resulting in chain reactions which will damage the cells of organisms. Antioxidants like thiols or vitamin C terminate these chain reactions. Many antioxidant compounds will be found in fruits and vegetables including phenolics, carotenoids, anthocyanins, and tocopherols. Tomato is one of the plant which produces an oversized number of diverse bioactive compounds and high concentrations of phytochemicals, which can protect against radical damage. Hence, tomato containing beneficial phytochemicals may supplement the needs of the body by acting as natural antioxidants [16]. Various studies have shown that several species of tomato are rich source of antioxidants. As an example, vitamins A, C, E, and phenolic compounds like flavonoids, tannins, and lignins all act as antioxidants. The consumption of tomato or their residues (leaves, seeds, stem etc.) has been linked with several health benefits, a result of medicinal properties and high nutritional value. With the several studies it has been found that the leaf extract contains the highest amount of antioxidants than any other part. Antioxidants control and reduce the oxidative damage in foods by delaying or inhibiting oxidation caused by reactive oxygen species, ultimately increasing the shelf-life and quality of those foods [17]. Beta carotene, vitamin C, and plenty of phenolics play dynamic roles in delaying aging, reducing inflammation, and preventing certain cancers. Increasing the consumption of leaves extract has been taken into consideration by many agencies and health care systems throughout the planet. Tomatoes are widely used as nutritional supplements. It is of interest is their value as a source of natural antioxidants [18]. Due to increasing safety concerns, committed consumption of synthetic antioxidants; exploitation of cheaper and safer sources of antioxidants from natural origins, and particularly from plants, is of interest nowadays. The foremost plant compounds characterized by antioxidant activity are polyphenols [19]. The antioxidant activity of polyphenols is accredited to their redox properties i.e., adsorbing and neutralizing free radicals, quenching singlet and triplet oxygen, and decomposing peroxides. The common and cosmopolitan group of phenolic compounds in plants is flavonoids [20]. These are present in most plants and are considered to stop radical - associated damages by numerous ways including direct scavenging of free radicals and inhibition of enzymes involved in free radical production. Antioxidants will be defined as bioactive compounds that inhibit or delay the oxidation of molecules. Antioxidants are categorized as natural or synthetic antioxidants [21]. Some synthetic antioxidants commonly used are: BHT, BHA, propyl gallate, and tert butyl hydro quinine. Many scientists have concerns about safety issues because synthetic antioxidants have recently been shown to cause health problems like liver damage, toxicity and carcinogenicity [22]. Therefore, the search for safer antioxidants from natural sources has increased, and plants are used as a decent source of traditional medicines to treat different diseases. Many of those medicinal plants are indeed good sources of phytochemicals that possess antioxidant

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activities. Some typical samples of common ingredients that are utilized in ethnic foods are tamarind, cardamom, lemon grass, and galangal basil. These spices or herbs are shown to contain antioxidants [23, 24]. Antioxidant properties are desirable for food, as oxidation causes pathogenesis of several human diseases and aging. It was observed that tomatoes exhibit high antioxidant properties because of the presence of several natural antioxidants such as lycopene, phenolic compounds, ascorbic acid etc.

Conclusion

Various antioxidant and antimicrobial properties are observed in tomato plants. The leaf extracts displayed both antioxidant and antimicrobial activity and the chlorophyll and flavonoids in the leaf extracts have shown to play a major role in their antioxidant functions [25, 26]. Such findings indicate that tomato plant extracts may be used as active sources of antioxidant and antimicrobial compounds. Tomato plant antioxidant activity is very important in order to prevent human beings from several bacterial as well as fungal diseases [27]. Future in-depth research work is needed on the tomato plants to develop formulations and therapeutics against many human diseases.

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