Journal of Materials and Environmental Science
ISSN : 2028-2508
e-ISSN : 2737-890X
CODEN : JMESCN


J. Mater. Environ. Sci., 2025, Volume 16, Issue 11, Page 2105-2125

http://www.jmaterenvironsci.com

# Natural Products and their Applications: A Review

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***Received*** *13 Sept 2025,*
***Revised*** *23 Oct 2025,*
***Accepted*** *24 Oct 2025*

**Keywords:**
- ✓ *Natural products;*
- ✓ *Antibiotics resistance;*
- ✓ *Primary Metabolites;*
- ✓ *Secondary Metabolites*

***Citation****: Kabir D., Mohammed A.S., Hamza M., and Lawan I. (2025) Natural Products and their Applications: A Review J. Mater. Environ. Sci., 16(11), 2105-2125*

**Abstract:** Natural products are chemical substances produced by living organisms and have been a dominant provider of drugs used to treat and manage a wide range of diseases and disorders, particularly cancer and infectious diseases. These natural products are also useful as food additives, flavouring agents, protect plant from diseases or enable the plant cells to better respond to the physiological stresses. These natural products are either sourced from plants, animals, marine, or microbes such as fungi or bacteria. Primary metabolites are natural products that are directly involved in the growth, development, and reproduction of living organisms, while secondary metabolites are used by humans as recreational drugs, food additives, and medications. Secondary metabolites are by-products of primary metabolism and are not necessary for the development and upkeep of cellular processes. This review discussed antimicrobial resistance, natural products and their sources, types, and their classifications. The review also discussed the broad biological applications of natural products in nutrition and food technology, medicine, agriculture, cosmetics, aiding plants' resistance against diseases, and serving as possible safe, natural, and environmentally friendly alternatives to chemosynthetic pesticides. This review also provided some explanations about some medicinal plants and the therapeutic applications of the natural products isolated from them.

## 1. Introduction

The resistance of pathogens towards antibiotics have reached a point where it has become disastrous in the world due to the way microorganisms defy the available known antimicrobials at an alarming rate (Danjuma and Lawan, 2025a). This drug-resistant infection is now among the leading causes of death globally (ARC, 2022). Antibiotic resistance is an ability of microorganisms to oppose antimicrobial agents. Antibiotics tend to lose their power to inhibit bacterial resistance. Worldwide, resistant bacterium is infecting humans, environment, and animals, crippling the economies of the middle and low-income countries (Danjuma and Lawan, 2025). The discovery of antibiotics is among the sterling findings of the decades ago, and these antibiotics have helped millions of people lived through infectious diseases (Salam *et al*., 2023). Antibiotics are not only used in medicine but also in agriculture, cosmetics, and food technology. The antibiotic therapy has altered the treatment paradigm, and it has saved millions of lives due to bacterial infections (Williams-Nguyen *et al*., 2016). Despite the fact that the last few years have witnessed several lives being saved by the discovery of the antibiotics, the growing trends of bacterial resistance to the antibiotics still persists (Jain *et al*., 2024). The number of deaths due to antimicrobial-resistant was estimated to be 1.27 million. In the year 2019, almost five million deaths were caused by drug-resistant infections. It is estimated that by 2050 this figure will grow up to 10,000,000 per year which is a significant number

compared to the deaths caused by cancer (Salam *et al.*, 2023; Danjuma and Lawan, 2025). The antimicrobial resistant infections cause severe morbidity, prolonged hospital stay, increased health care costs, increased secondary drug costs, and cure failure (Shrestha *et al.*, 2018; Bauer *et al*., 2019). Apart from the human health, the discovery and subsequent propagation of antimicrobial resistance due to the unscientific application of antimicrobials in livestock feeds in most developing nations has been one of the leading factors. It requires the intensification of monitoring the effects of overuse and uncontrolled administration of antibiotics in animal feeds to reduce the prevalence of drug-resistant bacteria (Ghimpet *et al*., 2022). As a result of antibiotics abuse on human and animal pathogens, the contaminated environment stores antibiotic resistance genes and becomes the reservoir which may subsequently be transferred between the environment, humans and animals via mobile genetic elements such as horizontal gene transfer like integrons, transposons, and plasmids (Manaia *et al.*, 2017; Pal *et al*., 2016). A coordinated collective effort among various national and international agencies is badly needed immediately otherwise, a postantibiotic era can become a more tangible reality (Salam *et al.*, 2023). Developing new antibiotics is extremely difficult because the process is complicated by the technological aspect, and it consumes considerable time, cost, and development process. The other obstacles are pivotal in the sense of poor knowledge of bacterial permeability, use of in vitro technologies that do not model host conditions, and complexity of bacterial systems. All these concerns negatively impact the current reductionist trends in the discovery of antibiotics that emphasize the necessity of developing new antibiotic treatments (Farha *et al*., 2025; Hatfull *et al.*, 2022).

Natural product refers to any substance that is produced by living organisms (Gonzalez-Manzano and Duenas, 2021). Natural products from different organisms have been a dominant provider of drugs used to treat and manage a wide range of diseases and disorders, particularly cancer and infectious diseases (Agarwal *et al*., 2020; Atanasov *et al*., 2021). Natural products are either from plants, animals, marine, or microbes, such as fungi (Singla *et al*., 2023). The plant tissues, marine organisms or fermentation by microorganisms among others can be used to extract natural products. Food wastes may also be a valuable source of bioactive compounds. A vast variety of compounds of various natural origins (i.e. phenolic compounds, dietary fibers, polysaccharides, vitamins, carotenoids, pigments and oils) may be of great diversity in biological action (Makinen *et al*., 2020). Natural products have been playing an essential role in health care over the decades. Natural products are the largest class of compounds that have been used in drug development since ancient times. Nature has been a wellspring of valuable biological agents, and thousands of new drugs are being obtained as a result of natural sources due to their traditional medicinal properties (Jalil *et al*., 2024). The natural products have been dominant in the treatment and cure of human diseases in thousands of years. The natural substances that form the basis of remedies also have various sources, including microorganism and land plants, sea micro and macro-organisms, terrestrial invertebrates as well as the vertebrate (Umeokoli *et al*., 2015). Nature presented great varieties of new opportunities concerning the treatment of various diseases by offering the mankind a diversity of minor bioactive substances. Natural products have been used to come up with the best-selling marketing drugs of the previous century (Taxol -T. brevifolia, morphine Papaver somniferum, and vincristine-Vinca rosea). The acid test of this has been the renaissance of interest that has been observed in academic world and pharmaceutical companies over the recent years towards natural products as an alternative source of drugs. Approximately 40 percent of the new drugs in practice are developed out of natural products (Refaz *et al.*, 2017). This study was done to review natural products and their applications in medicine, agriculture, nutrition, and cosmetics among others.

## 2. Sources of Natural Products

### 2.1 Plant Source

Plants have existed for centuries and have been used in traditional medicines for thousands of years to cure a variety of illnesses that afflicted humankind (Juliet *et al*., 2025). Most medicinal products that are currently being prescribed are of plant products, which are likely to rise even more with the discovery of additional plants with medicinal properties (Kadda *et al.*, 2021; Danjuma *et al.*, 2024). Bioactivities such as anti-viral, anti-inflammatory, anti-leishmanial, cardio-vascular, anti-diabetic agents, anti-obesity agents, anti-malarial agents, and immunomodulators are some examples of medicinal applications derived from plants. Plant-based natural products have also been shown as promising drug discovery by researchers isolating and characterizing bioactive phytochemicals from medicinal plants such as Talinum triangulare, Newbouldia laevis, and Opuntia ficus-indica (Umeokoli *et al*., 2015; Kadda *et al*., 2022; Nasim *et al*., 2022).

### 2.2 Animal Source

Animals are reservoir of some natural products and therapeutic drugs. For example, Epibatidine, which is an analgesic found to be more therapeutic in comparison with morphine, is obtained from the skin of a poison Ecuadorian frog. A number of ailments can be eliminated using venoms and toxins of some animals. For example, Cilazapril and captopril, both effective anti-hypertensive agents, were developed from teprotide, an extract from Brazilian viper (Juliet *et al*., 2025).

### 2.3 Microbial Source of Natural Products

With the increasing resistance to current antimicrobial agents, the microbes are excellent sources and targets of new antibiotic therapies, such as penicillin from Penicillium. Acremonium species produce rubens and cephalosporins that have proven to be invaluable antimicrobial agents combating bacterial infections (Lubek Nguyen *et al.*, 2022). Microorganisms have also been used in other therapeutic fields. As an example, cyclosporine A, a fungus toxin that was isolated from Tolypocladium inflatum, has transformed organ transplantation into an effective immunosuppressant (Bencheikh *et al.*, 2022). Microbial products of the same type (doxorubicin, produced by bleomycin and Streptomyces peucetius, isolated by Streptomyces verticillus) are also anti-cancer agents that are of critical use in the treatment of different malignancies (Silva *et al.*, 2023). Another antibiotic acquired in microbes (Streptomyces aureofaciens) can be used in the treatment of tetracycline and in a number of dental infections. Another bright representative is chloramphenicol produced by Streptomyces venezuelae and is employed in treatment of typhoid, cholera and in brain abscesses. Other microbe-derived drugs that have been developed till now include imipenem, norcardicin, aztreonam, and erythromycin. In recent years, intensive research has focused on endophytic fungi as a strategy for identifying new therapeutic agents. The plants have special kinds of microorganisms which are known as endophytes which are sources of novel bioactive natural products (Juliet *et al*., 2025). Bio-based pesticides are also being used in agriculture where synthetic pesticides are being substituted by microbe-derived pesticides because these are environmentally friendly. Bacillus thuringiensis, an insecticidal protein-producing bacterium has received extensive use in organic agricultural crops as a defence against pests (Dulovic *et al.*, 2024). Also, there are nitrogen-fixing bacteria, e.g. *Rhizobium* spp., that establish symbiotic associations with legumes, naturally increasing the soil fertility and lessening the need of chemical fertilizers (Nguyen *et al.*, 2022).

### 2.4 Marine Source of Natural Products

Water covers approximately 70 percent of the earth surface. Pharmaceutical firms discovered that the ocean could provide a potential source of rare biodiversity and could be a potential source of drug candidates. This marine biodiscovery exploration has led to the isolation of thousands of structurally unique bioactive marine natural products (Ouahabi *et al*., 2024; Juliet *et al*., 2025), including ziconotide, a peptide initially obtained in a tropical cone snail employed in pain treatment, plitidepsin, a depsipetide extracted out of Mediterranean Tunicate, Aplidium albicans, was utilized as a treatment of different cancers, spisulosine, extracted out of marine clam Spisula polynyma, displayed significant selective action on the tumour cells over the normal cells. Moreover, recent works have also examined the prospects of marine-based fungi as suppliers of new bioactive compounds (Ebube *et al*., 2023; Juliet *et al*., 2025).

## 3. Classifications of Natural Products

### 3.1 Primary Metabolites

The compounds known as primary metabolites include those compounds involved in the growth and formation of living organisms directly. Primary metabolites play a role in the growth, development, and reproduction of the organism. Moreover, primary metabolites such as amino acids, such as L-glutamate and L-lysine, are often used as supplements, which are achieved through the cultivation of a specific bacterial species, Corynebacteria glutamicum (Preeti, 2020). The primary byproducts of metabolic activities involved in several life-sustaining processes, including growth, reproduction, and cellular functions. Proteins, lipids, carbohydrates, and nucleic acids are some of the most prevalent primary metabolites. When necessary, nutrients are present in a growth medium, primary metabolite production starts during the active growth phase, or trophophase. Enzymes involved in respiration and photosynthetic processes are among the key metabolites of plants that contribute to energy production (Elshafie *et al*., 2023). Primary metabolites are also the primary building blocks of the fundamental cell structures, including proteins for peptidoglycan, cytoskeletons, and chitin for cell walls, and phospholipids for cell membranes. There are also nucleic acid primary metabolites that are composed of DNA as well as RNA used for storing and transmitting genetic information. Primary metabolites, conversely, perform their functions as signal molecules, which mediate defence responses by detecting pathogens and signal transduction. They are made up of peptides, biogenic amines, steroid hormones, auxins and gibberellins communication signals such as hormones and other growth factors (Elshafie *et al*., 2023; Hussaini and El-Ansary, 2018).

### 3.2 Secondary Metabolites

The secondary metabolites are critical in the plant defense against the herbivores and other interspecies defenses. Human beings use secondary metabolites as recreational drugs, flavors, colorants, and drugs. Primary metabolism is not a byproduct of secondary metabolism needed in the production and maintenance of cellular processes. These are the organic materials that are not directly involved in the normal growth, development and reproduction process of an organism. Secondary metabolites are also influential even on the food that people consume (Preeti, 2020). Some researchers have attributed the human food preferences which might have been brought about by the dietary foods that are driven by certain secondary metabolite volatiles. This has not been an issue that has been addressed completely explored; it has interesting implications to human health requirements. There are many of these secondary metabolites which assist the plant to acquire

nitrogen and other essential components. As an example, to increase their consumption of nitrogen, legumes use flavonoids to signal symbiotic relationship with nitrogen fixing bacteria (rhizobium). Therefore, many of the plants consuming secondary metabolites die and are nutritious and can be eaten by people. Plant secondary metabolites are classified into three primary groups based on their chemical structure; nitrogen containing chemicals, phenolics compounds, and terpenoids (Elshafie *et al.*, 2023; El Amri *et al.*, 2025).

It was reported that Saponins, flavonoids, thiosulfinates, glucosinolates, phenols, alkaloids and organic acids are some of the antimicrobial secondary metabolites used to treat a number of pathogenic microbes. In particular, isoflavonoids phenolics chemicals and aliphatic alcohols, aldehydes, ketones, and acids (terpenoids) are believed to be the main plant constituents that demonstrate good antibacterial activity. Furthermore, the phenolics have been shown to be abundant in a number of foods such as red cabbage which have compound anthocyanins, promoting bacterial activity (Elshafie *et al.*, 2023; Camale *et al.*, 2019). The two derivatives (plazomicin and sisomicin) of the aminoglycoside have been discovered to exhibit interesting antibacterial properties ( Newman and Cragg, 2020).

Poljsak *et al*. (2019) and Elshafie *et al*. (2021) reported that several plant families such as the *Asteraceae, Rosaceae,* and *Punicaceae* which produce bioactive secondary metabolites such as flavonoids, lignans, vitamins, carotenoids, and terpenoids have high antioxidant properties. Antioxidants are substances that are capable of suppressing the oxidation process; these chemical reactions have the capability to generate free radicals and chain reactions and have potentials of damaging cells (Danjuma *et al.*, 2025).

Recently, plant secondary metabolites known as polyphenols, terpenes, fatty acids, and many other bioactive substances have developed anti-inflammatory drugs with considerable efficacy. Aswad *et al.* (2018) stated that some plant secondary metabolites, such as hypaphorine, capsaicin, or moupinamide produced by *Erythrina velutina*, *chili pepper*, and *Zanthoxylum beecheyanum*, are used as potential new and effective anti-inflammatory drugs.

Some of the plant secondary metabolites have been demonstrated to have antioxidant potential due to their capacity to prevent oxidative stress, inflammation, and possess anticancer effect. These secondary metabolites are used as cancer therapeutic agents such as marine-derived bleomycin, actinomycin D and mitomycin C, irinotecan, vincristine, vinblastine, etoposide, and paclitaxel. (Block *et al.*, 2015) Moreover, the reduction in mortality caused by cancer is associated with the consumption of fruits and vegetables that are rich in vitamins, minerals, folate, plant sterols, carotenoids, and phytochemicals such as flavonoids and polyphenols. The herbs and spices, such as ginger, capsicum, curcumin, clove, rosemary, sage, oregano, and cinnamon, are very rich in antioxidants due to their high level of phenolic compounds and have been shown to reduce the effects of reactive oxygen species in various human malignancies (Aswad *et al.*, 2018; Block *et al.*, 2015; Huang *et al.*, 2021; Dionysia *et al.*, 2021).

## 4. Biosynthetic Classification of Natural Products

A significant portion of medications in the contemporary pharmaceutical setup can be traced back to their natural product origins, and many ancient medicines are made from natural sources. Many synthetic efforts have been motivated by these substances in an attempt to comprehend their complex structures and utilize their medicinal potential. These substances emphasize the significance of natural products in healthcare, agriculture and food technology (Danjuma and Lawa, 2025), from the beauty of morphine and quinine, which have transformed pain management and antimalarial therapy,

to the potent cancer-fighting substances like paclitaxel (Taxol) from the Pacific yew tree and the antibacterial wonders of penicillin. Chemists can improve their properties, discover new, more potent derivatives, and learn more about the mechanisms of action by comprehending their structures and synthesis (Sunita, 2023). Natural products, including secondary metabolites, function as both defensive systems and therapeutic agents for humans. For example, artemisinin has transformed the treatment of malaria and/or SARS-CoV-2 (Diass *et al.*, 2023; Rodrigues *et al*., 2024), while paclitaxel, which is derived from the Pacific yew tree (Taxus brevifolia), is an essential chemotherapy drug (Buljeta *et al.*, 2023). Products made from plants are also very beneficial to the personal care and cosmetics sectors. Aloe vera gel and shea butter, which are derived from Vitellaria paradoxa nuts, are frequently used in skincare products because of their calming and moisturizing qualities. Furthermore, anti-aging products often contain antioxidant-rich chemicals such papaya retinoids and green tea polyphenols, which provide natural ways to keep skin looking young and healthy (Ouahhoud *et al.*, 2022; Bouslamti *et al.*, 2023;). A drug called Azadirachtin which is powerful insect natural repellant used in organic agriculture to lessen reliance on synthetic pesticides is found in neem oil, which is derived from the Azadirachta indica tree (Nahar *et al.*, 2023).

### 4.1 Tannins

Tannins have antimicrobial effects against bacteria by destroying bacterial membranes and inhibiting the development of biofilm (Nair *et al*., 2020). They have also been depicted to possess a high scavenging power against superoxide and free radicals which indicates that they may be used as antioxidants in food industries. They also serve the role of pancreatic lipase inhibitors and mediate nutritional lipid digestion and, consequently, this can be used to regulate body weight (Qin, 2018). Tannins can scavenge free radicals (due to the presence of hydroxyl groups), and this capacity increases with an increase in the number of hydroxyll groups and molecular weight. Charoensiddhi *et al*. (2020) believe that a range of bioactivities can be displayed by some tannins as anti-inflammatory, anti-cancer, antdiabetic, antibacterial and anti-hypertensive effects.

### 4.2 Polyphenols

The epidemiological research findings over the recent decades has revealed that diet high in polyphenols can inhibit the onset of diabetes, cancer, cardiovascular disease, and other forms of neurological diseases (Pham *et al.*, 2020). Due to their ability to treat various health conditions, polyphenols have been employed in treating a number of illnesses. Polyphenols have numerous health-promotional properties including the reduction of the adverse impact of oxidation on the body, prevention of degradation of organs and cell structure and maintenance of their functional integrity. It is due to these properties that polyphenols possess strong bioactivity and thus they are endowed with high antioxidative, antihypertensive, immunomodulatory, antimicrobial, antiviral, and anticancer activity (Pham *et a*l., 2020).

### 4.3 Glycosides

A sugar moiety (glycone) and a non-sugar aglycone, or genin, make up the unique chemical structure of glycosides, which have garnered a lot of interest due to their various bioactivities and potential applications in modern medicine (Bartnik and Facey, 2017; Deshpande *et al.*, 2017 ; Yulvianti and Zidorn, 2021).

### 4.4 Flavonoids

Studies have established the antimicrobial effect of flavonoid compounds on the bacteria mentioned in the WHO list of priority pathogens (de Lima *et al.*, 2021). Some flavonoids also have antioxidant properties, antimicrobial activity, cytotoxic effect, anti-inflammatory activity, antitumor activity, enzyme inhibition, oestrogenic activity, anti-allergic activity, and vascular activity (Tasnim *et al.*, 2022). Flavonoid belongs to exogenous antioxidants which inhibit reactive species through blocking ionic channel modulation or xanthine oxide synthase. They also lower the oxidation of low density lipoproteins. The flavonoid phytochemicals inhibit and affect viruses in various ways including viral entry, viral replication, and protein translation. (Rodriguez-Negrete *et al.*, 2024) claim that flavonoids can inhibit the adhesion of viruses to cells, interfere with various stages of viral DNA replication, protein synthesis, and the processing of polyproteins. Flavonoids and other phytochemical substances have the benefit of increasing the chances of antioxidant activity since many studies have revealed a positive and rising correlation between these chemicals and antioxidant activity of extracts (Darkwah *et al.*, 2018).

Over 5000 flavonoids have been extracted in various plants. They are classified into flavanone, flavanonols, flavans, anthocyanidins and isoflavonoids depending on their chemical structures. Flavones that were extracted from tomato skins, red wine, buckwheat, red pepper, and various fruit skins demonstrated intriguing antiviral, anti-inflammatory, and antimutagenic properties. Flavanones have antibacterial and antimutagenic properties and are found in a variety of citrus fruits, including grapefruits, oranges, and lemons. Naringin and naringenin are examples of flavanones that have potent antioxidant and central nervous system neuroprotective properties (Mouffouk *et al.*, 2021; August and dos Santos, 2020).

### 4.5 Terpenes and Terpenoids

Terpenes have been discovered to be noteworthy inhibitors of the efflux pump (Dias *et al.*, 2022). These terpenes could either be extracted directly, synthesized chemically and by microbes. They are common in plants, especially Zingiberaceae or tulips. They are also useful in the digestive system and have antibacterial, antiviral, antioxidant, and analgesic effects. Terpenes are commonly used as anti-cancer agents as well as a dietary health component (Zhang *et al.*, 2018). They also add the fruity flavor for Chinese baijiu and are specifically used as active ingredients in fermented Chinese baijiu products. Limonene exhibits strong biological properties in drug preparations which activates tumor cell death, prevents tumor cell growth, and reduces tumor cell mitosis (Wang and Zhao, 2022; Newman and Bragg, 2020; Mei *et al.*, 2023). Also, terpenoids possess anti-inflammatory, antiviral, anthelmintic, hepaticidal, anti-carcinogenic, antimalarial, anti-ulcer, sesquiterpenoid, and antimicrobial or diuretic properties (Tasnim *et al.*, 2022).

### 4.6 Saponins

A class of secondary metabolites known as saponins is found in many plant and marine species. Plants often contain them in their roots, leaves, fruits, blooms, and seeds (Rai *et al.*, 2021). Hypocholesterolemic, antiviral, antimicrobial, antioxidant, immunostimulant, anti-inflammatory, antiviral, plant defense, and anti-carcinogenic qualities (Tasnim *et al.*, 2022). Saponins are useful in

drug development and therapeutic interventions because of their variety of bioactivities, which include anti-inflammatory, immunomodulatory, and anticancer properties, among others (Phuc *et al*., 2024). In addition to their potential as allelochemicals, several saponins have cardiac, hemolytic, cholesterol-lowering, sweetening, and cosmetic properties. The chemical characterisation of these compounds has attracted a lot of attention due to their application in plant pharmaceuticals, folk remedies (Audrey *et al.*, 2023).

### 4.7 Polysaccharides

A polysaccharide is a group of monomer sugar molecules joined by glycosidic linkages. Known as dietary fibre, they can be indigestible materials like lignin, cellulose, starch, pectin, hemicelluloses, among others. These compounds cannot be broken down by the digestive enzymes of humans. Regular consumption of dietary fiber lowers the risk of cancer, inflammation, high blood pressure, hyperlipidemia, hypercholesterolemia, obesity, and cardiovascular diseases while also enhancing insulin sensitivity and maintaining a healthy gut microbiota (Kumar *et al.*, 2023).

### 4.8 Alkaloids

About 20% of the secondary metabolites that are known to exist in plants are alkaloids. Both human treatment and an organism's natural defence depend heavily on alkaloids. It has been demonstrated that alkaloids work against resistant Escherichia coli by inhibiting efflux pumps, reducing the oxidative stress response, and interacting synergistically with ciprofloxacin. Additionally, this substance works well against Pseudomonas aeruginosa, Escherichia coli, and Methicillin-resistant Staphylococcus aureus (Jaktaji and Ghalamfarsa, 2021; Mehreen *et al.*, 2016). Alkaloids help plants fend off predators and control their growth. Alkaloids are especially well known for their anesthetic, cardioprotective, and anti-inflammatory properties in medicine. The alkaloids such as quinine, morphine, ephedrine, strychnine, and nicotine are all utilized in clinical contexts. Due to their potential in drug discovery as well as a very proactive development in the field of traditional medicines (ethnopharmacology), bioactive natural compounds have recently attracted renewed interest (Kaur and Arora, 2015; Kurek, 2019). According to Rodriguez-Negrete *et al.* (2024), alkaloids are powerful anti-cancer chemotherapeutic drugs that are frequently used to treat leukemia, lymphoma, lung cancer, osteosarcoma, breast cancer, gastric cancer, and ovarian cancer.

Morphine, derived from poppy plant, an analgesic and anesthetic alkaloid, is also used to reduce anxiety; Quinine derived out of Remijia sp. and was originally extracted in 1820 from the bark of a Peruvian cinchona tree, has antimalarial effects and is considered an important part of the List of Essential Medicines by the World Health Organization (WHO, 2021) to treat malaria; Ephedrine, a plant constituent of Ephedra sp., is anti-inflammatory and is used to treat low blood pressure in anesthetized patients; and Homoharringtonine, a plant constituent of Cephalotaxus fortunei, was approved by the United States Food and Drugs Administration to treat people with chronic myeloid leukemia. For almost 50 years, myeloid Homoharringtonine has been used to treat patients of leukemia in China. Despite resistance to special, specific treatment approaches by patients such as tyrosine kinase inhibitors, homoharringtonine is considered an important anticancer agent (WHO, 2021; Elshafie *et al.*, 2023).

### 4.9 Essential Oils

The essential oils are important class of secondary metabolites obtained from plant extracts and have been reported to have antibacterial properties. These substances have a strong fragrance, are volatile, complex, and hydrophobic. The unique colour and essence of their parent plants and spices are attributed to a naturally occurring volatile component known as an essential oil (Mimouni *et al.*, 2014). Contrary to what their name implies, essential oils are made from Quinta essential, the fragrant component of plants, and are not truly oils (i.e., lipids). In the US, essential oils are generally accepted to be safe for ingestion by humans and animals (Pharm *et al.*, 2020).

### 4.10 Steroids

The synthetic forms of the steroid cortisol, which include dexamethasone, cortisone, methylprednisolone, and prednisone, are also used to lessen the side effects of radiation and chemotherapy. It was discovered that testosterone is the hormone that gives males their sex traits and contributes to juvenile sexual maturity. The two primary categories of anabolic steroid consumption are pharmaceutical, or used as medicine, and anabolic. Anabolic steroids must work through two different processes: first, they promote the synthesis of proteins; second, they function as antagonists to the naturally occurring cortisol steroid, which contributes to stress-related mechanisms. As a result, they encourage cell growth and proliferation, especially in bone and muscle tissue. Pharmaceutical corticosteroids are only used to treat inflammatory and autoimmune conditions like lupus, asthma, allergies, Crohn's disease, atopic eczema, and others. Changes in the metabolism of carbohydrates, proteins, and fats; preservation of fluid and electrolyte balance; and preservation of the normal operation of the kidney, skeletal muscle, immune system, endocrine system, cardiovascular system, and nervous system are just a few of the many effects of corticosteroids. Furthermore, the organism may tolerate stressful circumstances such as unpleasant stimuli and environmental changes thanks to corticosteroids (Margarita *et al*., 2018; Roth and Johnson, 2018; Marike, 2023).

## 5. Some Medicinal Plants with Bioactive Natural Products

### 5.1 *Moringa Oleifera*

Moringa oleifera is a significant herbal plant that is called tree of life or miracle tree because of its enormous medicinal properties. It is used as antiulcers, pain reliever, wounds healer, suppress liver disease, cure heart disease, as anticancer, and anti-inflammation. Nearly all the parts (leaf, pod, bark, gum, flower, seed, seed oil, and root) of this plant have been utilized to treat one disease or another (Stohs and Hartman, 2015). Moringa oleifera is used as antihypertensive (Aekthammaratantianxiety *et al.*, 2019), anti-diarrheal and as a diuretic (Tahkur *et al.*, 2016). It is also applicable in the treatment of dysentery and colitis using moringa (Zhang *et al.*, 2020; Woldeyohannes *et al.*, 2022). The Moringa leaves can be used as a poultice to treat different inflammatory ailments that include glandular inflammation, headache, and bronchitis. The pods cure hepatitis and alleviate joint pains. The traditional treatment of kidney stones, liver diseases, inflammation, ulcer and ear and tooth pain is treated by the roots of moringa. Wounds and skin infections are treated with the help of the bark and stem of moringa (Ashutosh *et al.*, 2023). The gum of this plant is extracted and used by Indians to treat fever and also to induce abortions. The plant seeds are a laxative and treat tumors, prostate

and bladder issues. The seeds hold potential in the treatment of arthritis through changes, reducing inflammation and oxidative stress (Meireles *et al.*, 2020; Bhattacharya *et al.*, 2018). The plant leaf preparations are also useful in the nursing mothers and the malnourished infants. The leaves are useful in treating patients with insomnia and wounds. Today, the moringa is utilized immensely within the cosmetic sector, and in ancient Egyptian history. It was employed to create dermal ointments (Liu *et al.*, 2022; Gothai *et al.*,2016; Ashutosh *et al.*, 2023).

Table 1: Bioactive compounds from *Moringa oleifera*

| SN | Bioactive Compound | Chemical Formula | Plant part | Medicinal Applications | Reference |
|---|---|---|---|---|---|
| 1 | Kaempferol | $C_{17}H_{19}NO_3$ | Leaves | Oxidative damage, protective activity. | Ashutosh *et al.*, 2023 |
| 2 | Quercetin | $C_{15}H_{10}O_7$ | Leaves | anti-diabetic agent. | Ashutosh *et al.*, 2024 |
| 3 | Myricetin | $C_{15}H_{10}O_8$ | Seeds | Antidiabetic | Ashutosh *et al.*, 2023 |
| 4 | Ellagic acid | $C_{14}H_6O_8$ | Leaves | Antibacterial, antiviral, antioxidant | Leone *et al.*, 2015 |
| 5 | Caffeic acid | $C_9H_8O_4$ | Leaves | Antifatigue, helps weight loss, protects against herpes, anti-HIV, anticancer. | Leone *et al.*, 2015 |
| 6 | Ferulic acid | $C_{10}H_{10}O_4$ | Leaves | anticancer, antioxidant, antithrombotic, antiarrhythmic, and anti-inflammatory. | Leone *et al.*, 2015 |
| 7 | Sinapic acid | $C_{11}H_{12}O_5$ | Seeds | Cardioprotective, renoprotective, anxiolytic, neuroprotective | Ashutosh *et al.*, 2023 |
| 8 | Arachidic acid | $C_{20}H_{32}O_2$ | Seeds | Increased breast milk production | Borgonovo *et al.*, 2020 |
| 9 | Glucomorin gin | $C_{20}H_{28}KNO_{14}S_2$ | Seeds | Anti-inflammatory, pain relieving, anti-oxidant, antihypertensive. | Sari *et al.*, 2020 |
| 10 | β-sitosterol | $C_{29}H_{50}O$ | Stem | Antioxidant, cardiovascular, and immunomodulatory agent | Ashutosh et al., 2023 |
| 11 | D-mannose | $C_6H_{12}O_6$ | Flower | Used for treatment of deficiency caused by genetic defects, and acute urinary tract infections | Liao *et al.*, 2018 |

**Fig 1:** *Moringa oleifera* leaves

### 5.2 Mangifera indica

The mango, or Mangifera indica, belongs to the Anacardiaceae family and is grown in tropical and subtropical regions (Asif *et al.*, 2016; Coman *et al.*, 2019). Rich in proteins, organic acids, lipids, fatty acids, carbs, minerals, and bioactive substances, mangos are said to be the most widely consumed tropical fruit. Among them, phenolic chemicals (phenolic alcohols, phenolic acids, and flavonoids) and carotenoids (α- and β-carotene) are recognized for their biological characteristics (Kaur *et al.*, 2022; Zhang *et al.*, 2017). The primary bioactive substances identified in Mango include mangiferin, methyl and ethyl gallates,rutin, ferulic acid, hesperidin, gallotannins, gallic acid, and catechin; and gallic, caffeic, cinnamic, tannic, and chlorogenic acids. These compounds have anti-inflammatory, anticarcinogenic, antibacterial, and antioxidant qualities (García-Mahecha *et al.*, 2023).

Table 2: Bioactive Components Isolated from *Mangifera indica*

| SN | Bioactive Compound | Chemical Formula | Plant part | Uses | Reference |
|---|---|---|---|---|---|
| 1 | Ellagic acid | $C_{14}H_6O_8$ | Leaves | Antioxidant, antimicrobial, anti-inflammatory | Del Pilar *et al.*, 2019 |
| 2 | Quercetin | $C_{15}O_{10}O_7$ | Leaves | anti-diabetic agent | Del Pilar *et al.*, 2019 |
| 3 | Gallic acid | $C_7H_6O_5$ | Fruits | Antioxidant, anti-inflammatory | RodríguezGarcía *et al.*, 2022 |
| 4 | Mangiferin | $C_{19}H_{18}O_{11}$ | Fruits | Antimicrobial, antioxidant | RodríguezGarcía et al., 2022 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Kaempferol | $C_{15}H_{10}O_6$ | Leaves | Antio-oxidative damage | delPilar *et al.*, 2019 |
| 6 | Gaffeic acid | $C_9H_8O_4$ | Roots | Antifatigue, helps weight loss, protects against herpes, anti-HIV, anticancer. | DelPilar et al., 2019 |
| 7 | Hesperidin | $C_{28}H_{34}O_{15}$ | Fruit | Antioxidant, anti-inflammatory | Del Pilar *et al.*, 2019 |
| 8 | Epicatechin gallate | $C_{15}H_{14}O_6$ | Stem | Antimicrobial, antioxidant | RodríguezGarcía *et al.*, 2022 |
| 9 | Cinnamic acid | $C_9H_8O_2$ | Bark, fruits | Antioxidant | delPilar et al., 2019 |
| 10 | Tannic acid | $C_{76}H_{52}O_{46}$ | Fruitss | Anticancer, antioxidant, antimicrobial | Del Pilar *et al.*, 2019 |

**Figure 2:** Mango tree

## 6. General Applications of Natural Products

### 6.1 Applications of Natural Products in Nutrition

The advantages of a large range of fruits and vegetables, which offer various bioactive natural ingredients, have attracted a lot of attention lately. According to Banerjee *et al.* (2017), certain essential fatty acids that are isolated from a variety of fruits and seed oils have practical qualities that lower the risk of disease. Histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine are among the essential amino acids that are crucial for food and a number of body functions, including protein synthesis, tissue repair, and nutrient absorption (Fang *et al.*, 2019). Certain important amino acids can prevent muscle loss, boost mood, sleep, and sports performance, and speed up the healing process after surgery. Eating a nutritious, well-balanced diet that includes

essential amino acids can help most people meet their daily needs. Furthermore, a diet high in fiber has been suggested as a nutritional supplement to prevent diabetes, obesity, and hypertension (Barnerjee *et al.*, 2017; Loukili *et al.*, 2022; Ouahabi *et al.*, 2023).

### 6.2 Applications of Natural Products in Agriculture

Plant protection and growth promotion can be achieved with natural products. Actually, a number of secondary metabolites from microbial and botanical plants may generate plant hormones and systemic resistance, both of which favorably impact plant growth. According to the literature, a variety of plants, including neem, citrus, sage, menth, garlic, oregano, moringa, and others, or their individual bioactive components, have been used to control harmful weeds, pest infestation, and a number of bacterial and fungal diseases (Twaiji *et al*., 2022; Sinno *et al*., 2021; Elshafie *et al*., 2022; Grul'ová, *et al*., 2020).

### 6.3 Applications of Natural Products in Cosmetics

Because of their low toxicity to mammals, certain plant-based natural compounds are used in cosmetic preparations. They are used to treat dryness, eczema, acne, scavenging free radicals, and other skin protection issues. They are also utilized as hair colorants and growth promoters. It is possible to add natural ingredients to cosmetics to give them a pleasing scent, gloss, and other conditioning qualities. For instance, menthol is frequently used as a flavoring element in toothpaste and mouthwashes, which preserves the mouth and combines antibacterial efficiency. It also adds a wonderful fresh taste and stops plaque development, which can cause gingivitis and foul breath. For generations, skin and a wide range of dermatological conditions have been treated with natural solutions based on traditional therapies. Castor, coconut, sunflower, and olive oils are examples of hydrophobic liquid mixes of volatile chemicals that have been utilized for cosmetic purposes, including spot treatments, eczema, dry skin, and acne (Elshafie *et al*., 2023).

### 6.4 Applications of Natural Products in Medicine

Since ancient times, plant secondary metabolites and their derivatives have been used as medicinal agents to treat a wide range of illnesses and disorders. Specifically, a sizable portion of medications produced globally have plant origins, and the pharmaceutical business today uses a number of bioactive chemicals. Morphine, for instance, was the first naturally occurring substance to be extracted from the opium poppy (Papaver somniferum) in 1806 and was utilized as a precursor to a number of medications. An antimalarial medication called artemisinin, which is derived from Artemisia annua, contains sesquiterpene lactone and is used to treat malignant cerebral malaria brought on by Plasmodium falciparum. The highly oxygenated tetracyclic diterpenoid paclitaxel, which was extracted from Taxus brevifolia, functions as an antimitotic drug by preventing tubulin from polymerizing to form microtubules. A non-nucleoside reverse transcriptase inhibitor (NNRTi) of type-1 HIV and an inhibitor of AZT-resistant strains of the virus, calanolide A was extracted from Calophyllum lanigerum (Atanasov *et al*., 2015; Elshafie *et al*., 2023).

## 7. Conclusion

This review discussed the applications of natural products in the healthcare, food, and agriculture. Those natural products include morphine and quinine, which have transformed pain management,

antimalarial therapy and as potent anticancer agents. The review also discussed how secondary metabolites are used by humans as recreational drugs, flavourings, colouration, and medications. Secondary metabolites are by-products of primary metabolism and are not necessary for the development and upkeep of cellular processes. These are the organic substances that are not directly engaged in an organism's typical growth, development, or reproduction process. Natural products are excellent therapeutic agents regardless of whether they are derived from plants, marine, or animals.

**Acknowledgement,** Not applicable.

**Disclosure statement**: *Conflict of Interest:* The authors declare that there are no conflicts of interest.

***Compliance with Ethical Standards****:* This article does not contain any studies involving human or animal subjects.

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(2025) ; http://www.jmaterenvironsci.com