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EMBLICA OFFICINALIS (AMLA): A REVIEW

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ABSTRACT

Because they provide vital therapeutic advantages to humans, medicinal plants are key in encouraging a healthy lifestyle. In ancient medical systems such as Ayurveda, Common names for Emblica officinalis Gaertn. include Amla and Indian gooseberry, is highly valued for its nutritional and therapeutic qualities that help people regain their vigour and energy. This article examines many phytochemicals that were separated from E. officinalis, going into their molecular processes, pharmacological potentials, and ethnobotanical applications. In addition to information from 20 e-books and other botanical sources, the study integrates data from more than 270 publications that have been published or approved in the last five to six decades. Extracts from several parts of E. officinalis, particularly the fruit, are rich in polyphenols including gallic acid, ellagic acid, various tannins, minerals, vitamins, amino acids, fixed oils, and flavonoids like rutin and quercetin. Its efficacy in treating a wide range of ailments, such as cancer, osteoporosis, neurological disorders, hypertension, lifestyle diseases, infectious diseases, parasites, and inflammation, is attributed to these ingredients. Its ability to regulate pathophysiological molecular pathways and its antioxidant qualities, which shield cellular structures from oxidative stress, are responsible for these therapeutic effects. To discover, separate, and assess these chemical ingredients for their potential as nutrients and medicines, further methodical study is necessary.

1. INTRODUCTION

More than 8,000 plant species, including over 2,000 woody plants, have been utilised for centuries to treat a variety of illnesses. Whether in their pure form or as crude extracts, natural products made from bacteria, plants, and other creatures are essential to the pharmaceutical sector. In addition to newly developing illnesses that continue to challenge medical science, complicated and life-threatening disorders like diabetes and metastasis have been the focus of more medical study in the twenty-first century. However, traditional treatments have often been neglected in the search for synthetic compounds. Even if synthetic medications provide quick relief, there are still serious worries about their potentially fatal negative consequences on vital organs, including nephrotoxicity, hepatotoxicity, and in extreme cases, even death.[1]

Medicinal plants are a priceless gift to mankind since they help people live disease-free lives. According to reports, ancient societies lived longer because they led natural lifestyles and regularly consumed antioxidant-rich traditional herbs. According to studies, by halting oxidative damage caused by free radicals and reactive oxygen species (ROS), the phytochemicals and phytosterols included in fruits and vegetables reduce the risk of cellular damage.[2]

Because of their antioxidant qualities, several therapeutic plants are combined in ancient Indian healthcare systems including Ayurveda, Siddha, and Unani. A major position in Ayurvedic medicine is occupied by Emblica officinalis, technically known as Phyllanthus emblica, a member of the Euphorbeaceae family lists some of the other colloquial names for it. Rich in vital amino acids, vitamins, and minerals, especially vitamin C, which is more abundant in E. officinalis than in other citrus fruits, it has been prized as a nutritional tonic and therapeutic agent. Although all parts of E. officinalis are used medicinally, the fruit is most often employed in rasayana formulations, either alone or in conjunction with other traditional herbs, to treat both infectious and non-infectious illnesses. Because of its antipyretic and anti-inflammatory qualities, E. officinalis fruits are used extensively in India, as well as as a general health tonic in the winter. This review focusses on the molecular processes and bioactive phytoconstituents of E. officinalis to highlight its therapeutic capabilities.[3]

2. HISTORICAL BACKGROUND

Amla (Emblica officinalis) is said to have been According to ancient Indian history, it was the first tree

to sprout in the cosmos. China, India, Indonesia, and Southeast Asia are among the tropical and subtropical locations where E. officinalis is extensively found. Since ancient times, this plant has been used to treat a number of ailments associated to lifestyle choices, such as diabetes, hyperlipidaemia, disorders of issues with the eyes, the central nervous system (CNS), and more.

The small to moderately large deciduous tree E. officinalis has a crooked trunk, light grey bark that exfoliates in thin, uneven flakes, and a height of 8 to 18 meters. It produces axillary clusters of greenish-yellow blooms. The feathery, slender, non-oblong leaves have an acute or obtuse apex and a rounded base. They are tiny, sub-sessile, and densely spaced throughout the branchlets, with a length of 7 to 10 cm. The mature fruits have six vertical stripes and are spherical and greenish-yellow in colour. They taste highly acidic, astringent, and sour. The mesocarp of the fruit is edible, while the seed is enclosed by the hard, rocky endocarp.[4]

3. PHYTOCHEMICAL CONSTITUENTS

Its varied chemical makeup and rich nutritional profile Emblica officinalis has gained national attention for its tannins, mucic acid, amino acids, alkaloids, flavone glycosides, phenolic glycosides, flavonol glycosides, phenolic acids, sesquiterpenoids, norsesquiterpenoids, and carbohydrates. Compared to other fruits such as apple, lime, pomegranate, Perlette grape, and Pusa Navrang grape, the fruit juice of E. officinalis has the highest content of vitamin C (478.56 mg/100 ml).[5]

Previous research, however, incorrectly stated that E. officinalis contained two low-molecular-weight hydrolysable tannins, pedunculagin and punigluconin, respectively, rather than vitamin C. Owing to conflicting results from many studies, the presence of vitamin C in E. officinalis fruit is still up for dispute. Recent research by measured a number of phytoconstituents in a summary is provided of E. officinalis's comprehensive nutritional characteristics.[6]

4. POTENTIAL THERAPEUTIC APPLICATION

Because of its many therapeutic and pharmacological uses, Emblica officinalis is valued in all parts. The plant has been shown to have anti-oxidant, anti-inflammatory, anti-cancer, adaptogenic, anti-diabetic, nootropic, antibacterial, and immunomodulatory qualities. In addition to its therapeutic benefits, E. officinalis helps prevent hyperlipidaemia, osteoporosis, and many other diseases. A summary of the several molecular targets that E. officinalis's many chemical components.[7]

4.1. Antioxidant

Oxidative reactions may harm basic cellular components even though they are necessary for the body to operate normally. Nature has created a sophisticated antioxidant defence system to fight oxidative damage, which includes vitamins A, C, and E as well as enzymes such as peroxidase, glutathione (GSH), catalase (CAT), and superoxide dismutase (SOD). Higher consumption of foods high in antioxidants has been associated in studies with lower rates of morbidity and mortality as well as a decreased risk of developing certain illnesses.

It was thought that Emblica officinalis's high ascorbic acid (vitamin C) concentration was the cause of its antioxidant qualities until the 1990s. however, disputed this assertion in 1996, stating that ascorbic acid is absent from E. officinalis. Rather, they discovered that the real sources of its antioxidant activity were hydrolysable tannins, such as emblicanin A, pedunculagin, punigluconin, and emblicanin further verified that these tannoids, which have characteristics similar to those of vitamin C, were responsible for E. officinalis's antioxidant capacity.[8]

Due to their capacity to scavenge free radicals, pedunculagin, gallic acid, punigluconin, emblicanin A, and emblicanin B have all been connected to the antioxidant activity of E. officinalis. The DPPH experiment, evaluated a number of fruit extracts that were soluble in water and verified that they had a beneficial impact on Fe2+ reduction and superoxide anion radical scavenging. Rather than vitamin C, the existence of gallotannins and hydrolysable tannins, and ellagitannins was associated with this anti-radical action.

E. officinalis has also shown strong anti-urease action. The pathophysiology of urinary tract infections is significantly influenced by bacterial ureases. Using the phenol-hypochlorite technique, Bai et al. assessed the fruit and leaf extracts of E. officinalis for their anti-urease activity, and discovered that the IC_{50} varied between 0.74 and 4.54 mg/ml. Several bacterial species, such as Klebsiella pneumoniae, Pseudomonas aeruginosa, Proteus vulgaris, Staphylococcus aureus 109, and Staphylococcus aureus 3160, were significantly inhibited by the extracts.[9]

Examining Emblica officinalis fruit extract's ability to stave against alcohol-induced oxidative damage, they also pointed up the advantageous impact of polyphenols such flavonoids, tannins, and ascorbic acid in lowering oxidative damage. By scavenging nitric oxide (NOx), a substance that both pro-oxidant and antioxidant properties, these polyphenols, which are mostly found in fruit extract from E. officinalis, guard against oxidative stress brought on by alcohol.

Many other research teams have used both in vitro and in vivo models have verified the antioxidant function of polyphenolic substances, such as flavonoids and tannoids. While the pulp and seed of E. officinalis have unique phyto-pharmacological characteristics, The fruit's potent antioxidant properties are well known. The pulp exhibited more antioxidant capacity than the seed, according to, DPPH radical scavenging activity had IC_{50} values of 6 µg/ml and 13 µg/ml, respectively.

Discovered novel phytochemicals from E. officinalis, such as sesquiterpenoids and diphenyl ethers, that demonstrated cytoprotective efficacy against damage caused by hydrogen peroxide ($H2O_2$) in PC12 cells utilising cellular models. With IC_{50} values ranging from 3.25 to 4.18 µM, all of the identified compounds demonstrated significant DPPH scavenging action, which was ascribed to their antioxidant potential.[10]

4.2. Anti-diabetic and related metabolic functions

In order to effectively manage diabetes and associated metabolic problems, diet is essential. Many traditional plants have shown varied levels of antihyperglycemic and hypoglycemic effects. These effects are thought to be caused by processes such increasing insulin sensitivity, preventing the absorption of glucose from food, or encouraging pancreatic β-cells to secrete more insulin. Emblica officinalis has been shown to have antihyperglycemic properties in a number of clinical and nonclinical investigations. In diabetic patients, E. officinalis dramatically decreased postprandial blood glucose levels and fasting after a 21-day course of treatment, according to clinical research. A three-month clinical trial with uremic diabetic patients receiving routine haemodialysis in order to further validate the preventive benefits and (−)-epigallocatechin gallate (EGCG), the patients' antioxidant defence significantly improved, and their diabetic and atherogenic indices dropped. Notably, there were no negative medication effects, as seen by the stability of inflammatory responses, liver, and kidney function.[11]

Numerous investigations have also looked at E. officinalis in models of experimentally created diabetes, including rats with diabetes generated by streptozotocin (STZ), either with or without a high-fat diet. Administering E. officinalis significantly protected against 5-hydroxyfurfural and decreased antioxidant levels. Furthermore, it decreased glycosylated proteins and raised blood adiponectin levels, confirming its function in enhancing glucose metabolism in diabetics. Using STZ-induced diabetes models, similar investigations have repeatedly shown the anti-diabetic efficacy of several extracts from E. officinalis.

The main phytoconstituents of E. officinalis, including gallic acid, gallotannins, ellagic acid, and corilagin, are primarily responsible for its well-established anti-diabetic properties. These substances have anti-oxidant and anti-free radical qualities that help to better control metabolism. In animal models, Patel and Goyal further validated gallic acid's cardioprotective and anti-diabetic effects.[12]

In different research, emphasised how E. officinalis alcoholic extract can restore transaminase levels and aid in the recovery from diabetes brought on by alloxan. Calcium ions (Ca2+) and their impact on protein glycation and starch digestion are strongly related to the insulin-mimetic actions of E. officinalis. In BRIN-BD11, a clonal pancreatic β-cell line, an aqueous extract of E. officinalis increased glucose-dependent insulin release and improved basal insulin production. However, E. officinalis extract was unable to promote insulin production when extracellular Ca2+ was absent or when Ca2+ uptake inhibitors such as diazoxide were present. On the other hand, depolarised cells showed a considerable improvement in insulin secretion. E. officinalis significantly decreased in vitro enzymatic starch digestion and prevented protein glycation at higher doses (0.5–5 mg/ml).[13]

4.3. Anti-hyperlipidemic and related metabolic syndrome

In both developed and developing nations, ischaemic heart disease, obesity, type 2 diabetes associated with metabolic syndrome, hypertension, and stroke are serious health issues. Flavonoids and other bioactive phytochemicals found in many plants and their derivatives have shown hypolipidemic potential.

Cu2+-induced LDL oxidation models and rats fed cholesterol to demonstrate the antihyperlipidemic effects of Emblica officinalis extract both in vivo and in vitro. Both total and free cholesterol levels were significantly reduced by the extract in a dose-dependent manner. In cholesterol-fed subjects treated with E. officinalis, oxidised LDL (Ox-LDL), a crucial indicator for the early development of atherosclerosis, decreased, indicating that the plant's antioxidant qualities stop atherosclerosis from progressing. By lowering blood and hepatic cholesterol, triglycerides, phospholipids, and LDL cholesterol levels, E. officinalis also demonstrated strong anti-atherosclerotic efficacy in rabbit models given a high-cholesterol diet. Additionally, there was a significant decrease in aortic sudanophilia and aortic plaque development.[14]

E. officinalis's ability to decrease cholesterol is further explained by the fact that it directly inhibited HMG-CoA reductase activity. Additionally, the injection of E. officinalis decreased cholesterol levels via increasing the levels of the liver PPAR-γ (peroxisome proliferator-activated receptor gamma) protein. Additionally, there was an increase of Bcl-2 and a reduction in Bax expression, suggesting improved cell survival.

Over the course of two to six months of therapy, a number of clinical investigations have shown that E. officinalis lowers cholesterol in both healthy and type 2 hyperlipidemic individuals. Long-term administration protected against atherosclerosis and coronary artery disease without substantially changing normal physiological functions by lowering total cholesterol, LDL, and very-low-density lipoprotein (VLDL) levels while simultaneously raising HDL levels and lowering C-reactive protein (CRP).[15]

4.4. Cardio-protective

The cardioprotective and anticoagulant qualities of

Emblica officinalis have been shown in several preclinical studies conducted on lab animals, The development of atherosclerosis is mostly influenced by oxidised low-density lipoprotein (Ox-LDL) cholesterol rather than LDL cholesterol alone. Antioxidants are thought to be useful therapeutic agents since oxidative stress is a fundamental factor in atherogenesis. E. officinalis' in vitro anti-atherogenic. Fruit juice from E. officinalis blocked over 90% of LDL oxidation and stopped macrophages from absorbing Ox-LDL in other in vitro tests. E. officinalis ingestion significantly decreased blood glucose, cholesterol, and lactate dehydrogenase (LDH) levels in a 90-day feeding trial on developing beetal children.[16]

In addition to improving hyperglycemia, treatment with E. officinalis fruit juice restored antioxidant levels and haemodynamic parameters, such as contractile force and heart rate. Additionally, the medication decreased oxidative stress, heart hypertrophy, and mean arterial blood pressure rises brought on by diabetes. These effects were ascribed to the polyphenolic content of E. officinalis fruit juice, namely gallic acid.

E. officinalis's cardioprotective properties were further validated in a rat model of reperfusion after left anterior descending (LAD) artery closure. According to the research, rats treated with E. officinalis exhibited elevated phosphorylation of eNOS and Bcl-2, as well as upregulated expression of PI3K, Akt, and GSK3β, confirming its protective function against cardiac ischemia-reperfusion damage.[17]

4.5. Anticancer and anti-proliferative

Plants have been utilised to cure a variety of illnesses, including cancer, since ancient times. Natural compounds produced from plants now make up a significant percentage of anticancer medications that are sold commercially. Plant-derived polyphenols may have anticancer properties, according to experimental data from both non-clinical and clinical investigations. Inhibiting oxidative stress, lowering the synthesis of pro-inflammatory molecules, preventing DNA damage, and promoting apoptosis are just a few of the ways that polyphenols work. However, because of discrepancies between in vitro and in vivo results, the claimed anticancer properties of polyphenols and flavonoids are still debatable. Combining food-based phytochemicals with chemotherapy is seen to be a potential strategy for managing cancer.

By raising liver antioxidant levels, E. officinalis demonstrated strong anticancer efficacy, according to the research, which evaluated a number of enzymatic parameters. Its antioxidant qualities and modulatory influence on A DMBA/TPL-induced skin tumour model in mice was used in the in vivo investigation. In both situations, E. officinalis showed strong anticancer action. While caspase-9 remained unchanged, the extract caused, indicating an anti-metastatic activity. Crucially, the extract's selective anticancer effect was shown by the fact that it did not cause cytotoxicity in normal lung fibroblasts (MRC5).[18]

4.6. Anti-mutagenic

Numerous investigations have shown that Emblica officinalis contains a variety of secondary metabolites with anti-mutagenic qualities, including phenolates, glycosides, flavonoids, and terpenoids.

E. officinalis was shown to protect mice from cyclophosphamide-induced mutagenicity. Using the Ames histidine reversal test, further research on Triphala, an Ayurvedic formulation that contains a significant proportion of E. officinalis, demonstrated anti-mutagenic potential using Salmonella typhimurium TA98 and TA100 strains. The results demonstrated that E. officinalis therapy successfully reduced mutagenicity brought on by direct and indirect mutagens.[19]

A traditional Tibetan medicine including E. officinalis as an active ingredient, has excellent anti-metastatic activity in the SKOV6 ovarian cancer cell line. E. officinalis extract's in vitro genoprotective activity on human blood cells at a dosage of 20 µg/ml against fluoride (17, 34, and 51 µM) was assessed more recently by Thakur and Rao. By controlling cell cycle proliferation and reducing sister chromatid exchanges (SCEs), the extract dramatically decreased genotoxic indices. The potent antioxidant and free radical scavenging properties of E. officinalis were ascribed to its genoprotective activity, with EC50 values of 55.44 and 17 µg/ml, respectively.[20]

4.7. Cerebro-protective and anti-brain aging

Ayurveda classifies several plants as "medhyarasayanas" (cognitive rejuvenators) that improve mental and memory function. There are currently few pharmaceutical choices for treating complicated brain illnesses includes Alzheimer's, Parkinson's, and Huntington's diseases. However, the potential of semi-synthetic medications and a variety of phytochemicals produced from plants to treat neurological illnesses is being investigated more and more.

Changes in traditional and alternative complementary pathways are related with neuroinflammatory illnesses, including as prion diseases (e.g., mad cow disease), AD, PD, and HIV-associated dementia. Numerous phytoconstituents have been shown to have complement-inhibitory activity, which may help to reduce neuroinflammation linked to illnesses of the central nervous system (CNS).[21]

Research by Vasudevan and Parle showed that giving Anwalachurna, a traditional Ayurvedic preparation that contains Emblica officinalis, to young and old mice and rats improved their memory scores in a dose-dependent manner. Exteroceptive behavioural models revealed that E. officinalis corrected amnesia caused by scopolamine and diazepam. In a similar vein, Golechha et al.

examined E. officinalis's ability to cure memory impairments and examined its effectiveness against scopolamine-induced amnesia. Because of its various health benefits, these and other studies indicate that E. officinalis may be a potential therapy for dementia, which include anti-cholinesterase action, memory-enhancing qualities, antioxidant activity, and cholesterol-lowering effects.[22]

4.8. Hepato-protective

Traditional Chinese, European, and other allopathic medical systems, as well as Ayurvedic therapies, have a long history of using natural medicines to treat liver diseases. The emphasis has turned to the standardisation and evidence-based assessment of herbal products in the twenty-first century. Hepatoprotective potential is claimed by more than 600 commercial herbal preparations globally. However, environmental variables that affect the composition of herbs often result in variances in potency. Isolated herbal substances have shown promise in treating viral, toxic, and degenerative liver illnesses in spite of this diversity.[23]

The two main causes of hepatic impairment are inflammation and oxidative stress. Emblica officinalis contains phytoconstituents such ascorbic acid, gallic acid, flavonoids, and tannoids that shield hepatocytes from harmful oxidative stress and inflammatory damage.

By producing free radicals like CCl_3• and CCl_3-OO•, which upset lipid homeostasis, long-term carbon tetrachloride (CCl_4) treatment causes structural and functional liver problems, including steatosis. According to studies, E. officinalis has strong hepatoprotective properties against acute liver damage brought on by CCl_4. E. officinalis treatment decreased focal necrosis and hepatic infiltration, and the treated livers' histology was almost normal. Additionally, it reversed CCl_4-induced pre-fibrogenic damage by lowering elevated serum levels of lipid peroxidation (LPO), lactate dehydrogenase (LDH).[24]

When thioacetamide, an organosulfur molecule, breaks down, it produces hazardous metabolites both acute and chronic liver diseases, such as sulfine and sulfene damage, including cholangiomas, liver nodules, hepatic adenomas, and hepatocarcinomas. By maintaining the activities of SGOT, SGPT, Sultan et al. demonstrated that E. officinalis protects against thioacetamide-induced oxidative stress and early hepatocarcinogenesis by reducing thioacetamide-induced ornithine decarboxylase activity and DNA synthesis, as well as glucose-6-phosphate dehydrogenase (G6PD), glutathione (GSH), and glutathione peroxidase. E. officinalis' promise as a hepatoprotective agent has been supported by two other study groups that have proven its protective function against thioacetamide- and CCl_4-induced liver damage.[25]

4.9. Analgesic, antipyretic and anti-inflammatory

Studies have shown the anti-inflammatory effects of the aqueous component of a methanolic extract of Emblica officinalis on rats' hind paw oedema brought on by dextran and carrageenan. Furthermore, the effect of this fraction on the migration of human polymorphonuclear leukocytes (PMNs) stimulated by LTB4 and N-formyl-l-methionyl-l-leucyl-l-phenylalanine (FMLP) and the production of inflammatory mediators like thromboxane B2 (TXB2), leukotriene B4 (LTB4), and platelet-activating factor (PAF) was investigated. Despite blocking human PMN migration, the aqueous portion of E. officinalis had no impact on PAF, LTB4, or TXB2 synthesis during blood coagulation, suggesting that its anti-inflammatory effects do not require suppression of lipid mediator production.[26]

A randomised, open-label crossover clinical study including ten patients with type-II diabetes shown that 500 mg/day of fruit extract from E. officinalis significantly reduced platelet aggregation in both single-dose and multiple-dose regimens. 160.4 mg of low-molecular-weight hydrolysable tannins, namely pedunculagin, punigluconin, emblicanin-A, and emblicanin-B, were found in the 500 mg extract of E. officinalis and were linked to the anti-platelet action.[27]

4.10. Antimicrobial

Globally, infectious illnesses continue to be a major contributor to mortality and morbidity, particularly in developing and impoverished nations. Many research organisations now prioritise the quest for novel anti-infective drugs. Historically, the discovery of many therapeutically utilised antibiotics has been aided by chemical compounds obtained from traditional plants. However, the hunt for plant-derived antimicrobial compounds has been fuelled by the development in antibiotic resistance and the appearance of novel pathogens.

Plant-based compounds have shown strong antibacterial action in a number of in vitro and in vivo investigations. Numerous research have shown the strong antibacterial qualities of Emblica officinalis, suggesting that it might be a useful starting point for creating safe, efficient, and reasonably priced medicines.[28]

4.11. GI ailments

Natural phytoconstituents have been utilised to cure melanoma and other illnesses since ancient times. The prevention of gastrointestinal (GI) problems has been the main focus of phytochemical research, even though many natural therapeutic items are being utilised or explored for GI disorders. Preclinical research has shown that phytochemicals may help cure and prevent a number of gastrointestinal conditions, such as ulcerative colitis and Crohn's disease.

Significant ulcer-healing effects have been shown by a number of Ayurvedic herbo-mineral formulations that

include Emblica officinalis. Histopathological investigation has shown that In rats, acetic acid-induced ulcerative colitis is prevented by the antioxidant-mediated protective action of E. officinalis methanolic extract.[29]

In a number of experimental models, such as pylorus-ligated stomach ulcers brought on by hypothermic stress, indomethacin-induced ulcers, shaky rats, and ulcers brought on by necrotising agents, Al-Rehaily et al. investigated E. officinalis's anti-secretory and anti-ulcer properties. E. officinalis extract possesses potent anti-secretory and anti-ulcer properties, and cytoprotective qualities, according to pharmacological, biochemical, and histological results.[30]

4.12. Wound healing property

One of the main areas of current biomedical research is the creation of medications and formulations that aid in wound healing. Ayurveda refers to a group of remedies called Vranaropaka that are produced from plants, minerals, and animals and have the ability to cure wounds. Clinical studies and experimental wound models have been used to assess the wound-healing effectiveness of several of these plants.

Hydrogen peroxide ($H2O_2$) and inflammatory cells such as macrophages, mast cells, and neutrophils are pro-oxidants are often abundant near the wound site. The healing process may be accelerated by adding antioxidants to the wound microenvironment. Emblica officinalis's ability to cure wounds is ascribed to the presence of ascorbic acid and low-molecular-weight tannins such as emblicanin-A and emblicanin-B. These compounds enhance tensile strength, shrinking temperature, acid-soluble collagen, type III collagen, DNA synthesis, and the activity of extracellular signal-regulated kinase 1/2 (ERK 1/2), which promotes wound healing.[31]

5. OTHER TRADITIONAL USES

5.1. Dermato-protective

Modern biomedical research places a lot of emphasis on creating medications and formulations that aid in wound healing. Known as Vranaropaka, Ayurveda lists a number of medications originating from plants, minerals, and animals that have the ability to cure wounds. In clinical trials and experimental wound models, the ability of several of these plants to heal wounds has been assessed.

Typically, inflammatory cells including neutrophils, mast cells, and macrophages are prevalent near the wound site as well as pro-oxidants like hydrogen peroxide ($H2O_2$). Antioxidants may speed up the healing process when added to the wound microenvironment. Ascorbic acid and low-molecular-weight tannins, such as emblicanin-A and emblicanin-B, are added, is thought to be responsible for Emblica officinalis' ability to heal wounds. These substances improve DNA synthesis, tensile strength, shrinking temperature, type III collagen, acid-soluble collagen, and increased activity of extracellular signal-regulated kinase 1/2 (ERK 1/2), which promotes wound healing.[32]

5.2 Adaptogenic

The genotypic adaptability linked to Emblica officinalis extract was shown. The production of prostaglandins by the target tissue is necessary for this impact, but it has no influence on the rise in cortisol levels brought on by stress.[33]

5.3 Antidiarrheal

Emblica officinalis's antidiarrheal qualities in animals using a variety of experimental methods. In rats with diarrhoea brought on by $MgSO_4$ and castor oil, Significant antidiarrheal effects were shown by the methanolic extract of E. officinalis. It also decreased intestinal motility in tests of gastrointestinal motility caused by PGE_2 and charcoal meal. Mehmood et al. also shown its antidiarrheal effectiveness in mice with castor oil-induced diarrhoea and intestinal fluid buildup. Furthermore, research on the guinea pig ileum and rabbit jejunum showed that E. officinalis had mixed action similar to that of dicyclomine and nifedipine. Its dual mode of action, which involves calcium channel inhibition and muscarinic receptor blocking, is probably what causes this antidiarrheal and spasmolytic effect.[34]

5.4 Anti-hyperthyroidism

Over a 30-day treatment period, the effectiveness of the effectiveness of an ethanolic extract from Emblica officinalis against mice's hyperthyroidism caused by L-thyroxine was evaluated, and comparisons to propylthiouracil were made. The findings demonstrated that E. officinalis was more efficient than propylthiouracil in lowering T_3 and T_4 levels, which were lowered by 64% and 70%, respectively. Despite its hypothyroid effects, the E. officinalis extract-maintained antioxidant levels and glucose-6-phosphate dehydrogenase (G6PD) activity. [35]

5.5 Aphrodisiac

In Ayurveda, Emblica officinalis is considered a strong aphrodisiac and one of the most effective herbs for rejuvenation. It is an important component of traditional medicine and the main component in the well-known Ayurvedic polyherbal formula Chyavanprash, which is well known for improving general health and sexual vigour.[36]

5.6 Appetizer

To increase appetite, Emblica officinalis green fruits are often pickled. After 45 days of taking Triphala, a well-known Ayurvedic treatment that incorporates E. officinalis as a key component, Mukherjee et al. demonstrated a substantial improvement in appetite and gastrointestinal issues in a clinical study including 160 patients.[37]

5.7 Diuretic

Bladder irritation and urine retention have long been treated using the fruits of Emblica officinalis, either by itself or in conjunction with rose water, Crocus sativus (saffron), and Nelumbium speciosum (Egyptian Lotus). For these circumstances, curcuma longa, often known as turmeric or Indian saffron, is sometimes used instead of saffron. A decoction of fresh E. officinalis fruit and For centuries, people have used the stem of Tinospora cordifolia (Guduchi), with or without honey, to treat a number of urinary tract ailments.[38]

5.8 Improves hair growth

In order to strengthen hair, encourage growth, and delay the onset of greying, emblica officinalis is often used as a hair tonic. A vital component of many shampoos and hair oils, the dried fruits of E. officinalis are prized for their nutritional value for hair and for their ability to stimulate hair growth in a concentration-dependent way.[39]

5.9 Immunomodulator

Because of their capacity to modulate the immune system, a variety of plants have been employed to cure human illnesses since ancient times. Plant-based therapies have been shown to have immunostimulatory effects in traditional medicine, such as Ayurveda. In BALB/c mice treated with E. officinalis, Suresh and Vasudevan found a twofold increase in natural killer cell activity and antibody-dependent cellular cytotoxicity. They credited E's high ascorbic acid content with having this immunostimulatory effect. officinalis. E. officinalis treatment showed enhanced lymphocyte proliferation in response to lipopolysaccharide and concanavalin-A intoxication, as well as advantages for oxidative stress protection and immunosuppression caused by chromium. Additionally, it restored levels of interferon-γ and IL-2 and dramatically decreased DNA fragmentation. E. officinalis's tannins improved humoral immunity, shielding against coccidial infections brought on by Eimeria species.[40]

5.10Laxative

In India, the fresh, ripe fruits of E. For centuries, officinalis has been utilised as a mild laxative usually, one or two fruits are used in a dosage. Due to its laxative qualities, the fruit is often pickled or preserved in sugar. There have also been reports of laxative effects from combining Terminalia officinalis with Terminalia bellirica and Terminalia chebula.[41]

Research revealed that the unrefined extract of E. officinalis exhibited laxative and prokinetic effects that were dosage dependant. Phytochemicals such terpenes, alkaloids, tannins, saponins, flavonoids, and coumarins are abundant in the extract, demonstrated atropine sensitivity, suggesting that muscarinic receptors are involved in its action. At dosages ranging from 0.003 to 0.1 ng/ml, aqueous and petroleum extracts of E. officinalis relaxed the isolated rabbit jejunum and guinea pig ileum, indicating that its prokinetic and laxative actions are caused by partial activation of muscarinic receptors. It's interesting to note that these results are in contrast to 2011 research conducted by the same group, which found that E. officinalis fruit juice decreased spasms by blocking both calcium channels and muscarinic receptors. According to both researches, the phytochemical content or preparation technique may have an impact on E. officinalis's ability to selectively bind to calcium channels and muscarinic receptors.[42]

6 CONCLUSION

The negative side effects and problems of contemporary pharmacological therapies have rekindled interest in research on ancient medicinal herbs. Drugs made from plants are used extensively as nutraceuticals in primary healthcare across the world. Numerous contemporary medications, including morphine, quinine, scopolamine, and atropine, have either been directly or indirectly developed from medicinal plants. Vincristine, etoposides, and camptothecins are examples of plant-derived chemicals that have shown strong anticancer promise in clinical studies, which has led to their widespread usage in medicine.

Consolidating the therapeutic potential of Emblica officinalis from published findings was the goal of this study. According to the data, a lot of work has gone into determining E. officinalis's whole pharmacological profile. E. officinalis has been used historically to treat a variety of illnesses since ancient times. More evidence-based research is still required, despite the fact that many clinical trials have shown its therapeutic effectiveness against pathological illnesses including cancer, diabetes, atherosclerosis, cardiovascular disorders, thrombotic events, and neuropathy. Every portion of E. officinalis has unique medicinal qualities, and it is accessible all over the world. Due to its wide range of pharmacological advantages, E. officinalis may be used as a medicinal agent with several targets. To isolate, identify, and assess its active chemical ingredients for use in medicine and nutrition, further methodical study is necessary.

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