A Review on Plant Profile of Artemisia Annua and Its Pharmacological Benefits

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ABSTRACT

The awareness of medicinal plants and its medicinal value must have been accumulated in the lots of centuries but it is our bad luck that proper chemical and pharmacological evaluation of most of these plants have not done till now. Keeping this view details studies on ethno botanical study of *Artemisia annua*. The plant *Artemisia annua* which is well-known for its ability to treat malaria. *Artemisia annua* has been researched for a wide range of biological activities, such as its ability to regulate the immune system, fight cancer, and have metabolic effects. Secondary metabolites such as monoterpenes, sesquiterpenes, and phenolic chemicals, whose biological characteristics have been thoroughly researched. Sesquiterpene lactone artemisinin is mostly found in the leaves of *Artemisia annua*. The potential value of this chemical and its derivatives as anti malarial medicines has drawn interest. This review will focus on *Artemisia annua* plant benefits of using medicinal herbs.

Keywords: Artemesia annua, Sesquiterpenes, Coumarins, Antiviral activities, Antibacterial activities, Antifungal activities

INTRODUCTION

Chinese herb *Artemisia annua* is 70–160 cm tall, heavily branched, slightly hairy, and highly scented. The stem is tall, ribbed, violet-brown to brownish, and coated in tiny, sparse hairs. The leaves are alveolate, ovate, glandular, and measure 3–5 cm in length and 2–4 cm in width. They are separated into petiolated lower leaves, sessile upper leaves, and bracteal highest leaves. The paniculate inflorescence creates a globosecapitulum with a diameter of 2.0–2.5 mm, which is then tightly packed on short branches. Within, the involucres bracts are oval or nearly spherical with a broad, glossy, scaly edge; the outside bracts are bordered with green. The surface of the receptacle is glabrous and convex. The flowers along the perimeter are hermaphrodite, weighing between 10 and 30 grams, cupped and light. They have a narrowly linear anther with long apical and short basal appendages. The pistillate flowers are 10 to 20 grams, filamentous, punctate, and have sharp ends on their stigmas, which protrude from the corolla tube. The stigma lobes are straight, slightly divergent, and ciliated at the tip, and the stamens are longer than the style. The achenes have a thin membranous border and are 0.6–0.8 mm long, spherical, and elongated (Soni, Shankar, Mukhopadhyay, & Gupta, 2022). They also have a tiny, apically rounded areola. *Artemisia annua*, sometimes known as "annual absinthe," is a herbaceous plant that blooms once a year, which accounts for its name. The plant is grown in temperate parts of America, Africa, Australia, Asia, India, and Central and Eastern Europe, as well as in tropical regions (Alesaeidi & Sepide, 2016)(Willcox, 2009). In the mild climates of Asia, such China and Korea, it is widely utilised as a medicinal plant, herbal tea, and spice in food.

There are many genera in the family Asteraceae, and one of the biggest and most extensively spread in the globe is the genus Artemisia and *Artemisia annua* is on from them. This genus includes species that are grasses, shrubs, or bushes that are erect or ascending, usually aromatic, and can be perennial, biennial, or annual. These plants have alternating, frequently split, rarely entire leaves with smooth edges. In addition to *Artemisia annua L*., other highly recognised species in the genus are *Artemisia afra, Artemisia absinthium,* and *Artemisia abrotanum*. In China, Europe, and Africa, these species were used to treat fever and malaria, respectively. In addition to many other nations in Europe, North America, and the tropics, *Artemisia annua* has been introduced. Lower latitudes have been successfully cultivated in many tropical nations, including as the

Congo, India, and Brazil, thanks to the adaptation of seed varieties through breeding. On the other hand, outside of China, *Artemisia apiaceahance* is less common and seldom grows (Valles, et al., 2011). It used for many years in Asia and Africa's traditional medicine to cure fever and malaria, usually as squeezed juice or tea (Zeljkovic, Maksimovic, Vidic, & Paric, 2012)(Mueller M. , Karhagomba, Hirt, & Wemekor, 2000). The dried herb *Artemisia annua* is officially listed as a treatment for fever and malaria in the People's Republic of China's current pharmacopoeia (Gupta, Dutta, Joshi, & Lohar, 2009). The recommended daily dosage is 4.5–9 g of dry herb made as an infusion. This herbal concoction has been utilised in clinical studies. It also have anti-hyperlipidemic, anti-plasmodial, anti-convulsant, anti-inflammatory, anti-microbial, anti-cholesterolemic, and antiviral effects of *Artemisia annua* have been reported(Abad, Bedoya, Luis, & Paulina, 2012)(Wang, Cui, Chang, & Guan, 2020)(Lubbe, Seibert, Klimkait, & Kooy, 2012).The plant's therapeutic effects are further enhanced by its significant pharmacological properties, which include anti-inflammatory, anticancer, and anti-obesity properties(Ho, Peh, Chan, & Wong, 2014)(Kim, Seo, Liu, & Kim, 2014)(Wang, et al., 2013). The plant contains more than 600 secondary metabolites, many of which include sesquiterpenoids, triterpenoids, monoterpenoids, steroids, flavonoids, coumarins, alkaloids, and benzenoids (Bhakuni R. , Jain, Sharma, & Kumar, 2000)(Li, Dong, Ma, Wu, Yan, & Cheng, 2019)(Zhao, et al., 2014).

Figure1: Image of Artemesia Annua Plant

Artemisia annua Chemical Compounds and Their Functions

Unlike essential oil extracts, which vary very little, the chemical composition and biological qualities of *Artemisia annua's* aqueous or alcoholic extracts can vary significantly based on the plant material employed, the region of origin, and the method of treatment (Castilho & Figueira, 2013).

Monoterpenes

The primary constituents of *Artemisia annua's* essential oil, which give the plant its powerful and fragrant aroma, are monoterpenes (Janackovic, et al., 2019). 1,8-cineole, α-and β-pinene, camphene, borneol, camphor, carvone, limonene, α-terpinene, and myrtenol are the primary constituents of the essential oil(Bora & Sharma, 2011)(Janackovic, et al., 2019)(Magalhaes, Pereira, & Sartoratto, 2004). Monoterpenes have the chemical formula $C_{10}H_{16}$ and are a kind of terpenes made up of two isoprene units. Monoterpenes can have rings or be linear (acyclic). Monoterpenoids are modified terpenes, such as those without a methyl group or having oxygen functionality. Plants produce secondary metabolites called monoterpenes.

Sesquiterpenes

Sesquiterpenes are known to act as a biocide or defence agent against organisms that are not part of the plant. Sesquiterpenes are a class of terpenes having the chemical formula $C_{15}H_{24}$, made up of three isoprene units. Sesquiterpenes, like monoterpenes, can have rings or be acyclic, with many different possible combinations. The related sesquiterpenoids are produced via biochemical changes such oxidation or rearrangement. The *Artemisia annua* plant contains about thirty sesquiterpenes, most of which are found in the aerial sections.

Artemisinin, artemisinin B, and artemisinic acid are the primary constituents (Fu, Yu, Wang, & Qiu, 2020)(Zhai, Supaibulwatana, & Zhong, Inhibition of tumor cell proliferation and induction of apoptosis in human lung carcinoma 95-D cells by a new sesquiterpene from hairy root cultures of *Artemisia annua*, 2010)(Li, et al., 2003)(Nam, et al., 2007)(Zhai, Supaibulwatana, & Zhong, Inhibition of tumor cell proliferation and induction of apoptosis in human lung carcinoma 95-D cells by a new sesquiterpene from hairy root cultures of *Artemisia annua*, 2010). Artemisinin's low solubility in both oil and water limits its medicinal usefulness. Dihydroartemisinin (DHA), an active metabolite; artesunate (ART, polar derivative); artemether (lipid-based derivative); artether (lipid-based derivatives); SM905 (1-(12β-dihydroartemisinoxy)-2-hydroxy-3-tert-butylaminopropane maleate, new water-soluble derivative); artemiside (a 10-alkylamino sulphide derivative, lipophilic with limited water-solubility); artemisone (a new 10-alkylamino sulfone derivative with enhanced water-solubility and decreased toxicity); and SM934 (β-aminoarteether maleate, new water-soluble such as cancer, autoimmune diseases, diabetes, viral infections, parasitosis, and atherosclerosis(Wang, Wang, You, & Xue, 2020)(Efferth, From ancient herb to modern drug: Artemisia annua and artemisinin for cancer therapy, 2017). Many disorders can be treated with artemisinin and its derivatives.

Phenolic compounds

These are secondary metabolites that plants make to defend against UV rays and animal attacks. Because of their bitter taste, they frequently serve as repellents. Phenolic chemicals are defined as molecules with one aromatic ring (benzene) and one alcohol group; this is the fundamental structure known as phenol. Organic molecules called phenolic compounds are found in large quantities in all parts of plants, from the roots to the fruits. These compounds don't directly contribute to the development or reproduction of plants or other fundamental plant functions. They are found in large quantities in the kingdom of plants in both simple (one aromatic ring) and more complicated (aromatic fused rings) forms, usually with a high molecular weight. Aqueous and alcoholic extracts of *Artemisa annua* include various types of phenolic chemicals (Ferreira J. F., Luthria, Sasaki, & Heyerick, 2010)(Han, Ye, Qiao, Xu, Wang, & Guo, 2008)(Lai, Lim, Su, Shen, & Ong, 2007)(Carvalho, Cavaco, & Brodelius, 2011). Quinic acid is a cyclotol; caffeic acid is a phenolic acid; Flavonoids: rutin, luteolin, isorhamnetin, kaempferol, mearnsetin, artemetin, casticin, cirsilineol, eupatorine, chysosplenetin, and chysosplenol D.

Coumarins

The plant is shielded by coumarins against pathogenic microbes and animals. To "save metabolic energy," they are mostly found on the surface and in the parts of the plant that are most vulnerable to predators, such as young leaves, fruit, and seeds. Natural compounds called coumarins are formed from benzo-α-pyrone. They originate in the leaves and mostly gather in the roots, bark, and older or injured tissues. Scopolin and scopoletin are the primary coumarins present in alcoholic extracts of *Artemisia annua*.

Pharmacological activities of Artemisia annua

Anti-Helminthic Activities

It was also discovered that artemisinin and its derivatives were effective against certain nematodes. In an in vitro investigation, adult Toxocaracanis treated with artemether underwent cuticular alterations that were faster to take effect than those brought on by albendazole sulfoxide (H A, S, K A, & A A, 2009). A number of possible modes of action were outlined, such as interference with the activities of the parasite's mitochondria, sarcoplasmic/endoplasmic reticulum Ca2+-ATPase PfATP6, and ion pumps on the apical plasma membrane (Golenser, Waknine, Krugliak, Hunt, & Grau, 2006). Additionally, investigations conducted both in vitro and in vivo have shown that artemisinin can treat adult and larval Toxocaraspiralis. Regardless of the treatment ways, artemisinin derivatives significantly decreased the overall worm rates; female worms showed a greater reduction rate than male worms. Derivatives of artemisinin also markedly decreased the load of worm eggs and granulomata generated by eggs in the liver of the host animals. Artemether and arteether have been reported to be equally effective against the sensitive strain of *S. japonicum* and the praziquantel-resistant strain (Yu-Jie, et al., 2015). The mechanisms of action of artemisinin against adult and larval *Toxocara spiralis* worms are thought to stem from damage caused by toxic free radicals and the suppression of VEGF expression, which inhibits parasite angiogenesis and may have an impact on the larva worms' ability to remove waste and maintain nutrition (Yun-Jeong, Jin-Ok , Min-Kyoung, Hak-Sun , Mee Sun, & Hee-Jae, 2011). Haemonchuscontortus in ruminants and plant nematodes (Meloidogyne spp., Globoderarostochiensis, and Xiphinema index) are other nematodes on which artemisinin and Artemisia extracts have been studied (Echeverrigara, Zacari, & Beltrao, 2010).

Antiparasitic properties of Artemisia annua

Antiplasmodial activity

When given to mice with malaria, *Artemisia annua* ether extract was efficacious in 95–100% of instances (Hsu, 2006). Nevertheless, artemisinin was quickly metabolised, passed out of the circulation in a matter of hours, and did not eradicate the parasite's liver stages (White, 2008). It cannot therefore be used as a preventative medication. In order to lower the likelihood of parasite resistance and recrudescence, the World Health Organisation now advises using artemisinin combination treatments as the first line of treatment for uncomplicated malaria (Organization, 2006). Malaria patients in Central Africa who were given *Artemisia annua* tea at a dosage in accordance with Chinese pharmacopoeia guidelines reported a very quick elimination of malaria parasites from their blood. After receiving *Artemisia annua* tea treatment for malaria, five patients reported a prompt 2–4-day reduction in parasitemia. In a follow-up study involving 48 malaria patients, 44 patients (92%) had no parasitemia after 4 days. There was a noticeable improvement in symptoms in both studies (Mueller M. , Karhagomba, Hirt, & Wemekor, 2000).

Antioxidant Activities

Due to the presence of phenolic compounds Artemisia annuagives antioxidant activities (Iqbal, Younas, Kim Wei, Zia-Ul-Haq, & Ismail, 2012). Artemisia annua's antioxidant action can be attributed to the existence of specific chemical families, including terpenes, flavonoids and coumarins. It is important to note that the primary component responsible for this plant's antioxydant effect has been discovered as chrysoprenol D (molecular formula $C_{18}H_{16}O_8$), a flavonoid (Messaili, Colas, Fougere, & Destandau, 2020). It was discovered that the main mechanism of action of the chemicals in the *Artemisia annua* extract was hydrogen atom transfer as opposed to single-electron transfer. Based on the use of the 2,2-diphényl-1-picrylhydrazyle (DPPH), 2,20-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS) diammonium salt), Oxygen Radical Absorbance Capacity (ORAC) tests, and metal chelating ability using the ferrozine assay, another study demonstrated the antioxidant properties of *Artemisia annua* essential oil.

Antidiabetic Activities

In diabetic rats, Artemisia annua aqueous extracts exhibit strong anti-hyperglycaemic and anti-hypoinsulinemia effects. Indeed, when mice were given the aqueous extract at a dose of 28.5 mg/kg twice a day, their blood glucose levels were decreased (Bhakuni R. , Jain, Sharma, & Kumar, 2000). This could be caused by increasing insulin activity, inhibiting the α cells in the pancreatic islets, or stimulating the β cells that secrete insulin (Winkelman, 1989).

Furthermore, it is now widely known that oxidative stress, the inflammatory response, and insulin action are all closely related. This makes sense given that antioxidants both enhance glucose metabolism and offer protection from the harmful effects of hyperglycaemia. These antioxidants are mostly flavonoids that have been shown to act on biological targets such aldose reductase, glucose cotransporter, and α-glycosidase that are involved in type 2 diabetes mellitus (Zoair, 2014). The protective effect of *Artemisia annua* extract's essential oil components (camphor, germmacreneD, Artemisia ketone, 1,8-cineole) against hepatocyte damage may be attributed to their inhibition of the proinflammatory mediators' expression when lipopolysaccharide (LPS) is present. These mediators include TNF-α (tumour necrosis factor alpha), iNOS (inducible nitric oxide synthase), COX-2 (cyclooxygenase 2), and IL-1β (interleukin 1 beta) (Ferreira & Gonzalez, 2009).

Immunomodulatory Activities

Numerous investigations on the immunoregulatory effects of artemisinin and its derivatives have been conducted (Efferth, et al., 2003). They alter important immune system effectors, such as toll-like receptors

(TLRs) (Wenbo, Feng, & Hui, 2016)(Wojtkowiak-Giera, et al., 2019). Two investigations showing the immunomodulatory action of *Artemisia annua* water extracts on TLR2 and TLR4 immune system components. In the first, the impact of *Artemisia annua* extracts on TLR2 and TLR4 expression in mice infected with Canthamoeba was assessed. TLR2 expression was markedly lowered and TLR4 expression was changed by the *Artemisia annua* extract. Through their ability to identify molecular patterns linked to host-derived damage or patterns associated with pathogens (PAMPs), these receptors are crucial in the detection of pathogens, including parasites. (DAMPs)) and cause the synthesis of inflammatory mediators (Kawai & Akira, 2009). The most well-known and extensively researched members of this family are TLRs 2 and 4 (Cario, Brown, McKee, Lynch-Devaney, Gerken, & Podolsky, 2002). The second study assessed how *Artemisia annua* extracts affected the expression of TLR2 and TLR4 in the lungs of mice infected with acanthamoebiasis. It was therefore proposed that extracts from *Artemisia annua* might have anti-inflammatory effects by down regulating the expression of TLR2 mRNA. Using artesunate, a common derivative of artemisinin, in vitro investigationsTLR4 and TLR9 mRNA expression was likewise reduced by artesunate. TLR4 is a receptor that triggers the activation of the inflammatory response by attracting adaptor proteins like MyD88, which activates the nuclear factor NF-κB and causes the release of pro-inflammatory cytokines. It should be mentioned that artesunate inhibits the production of TLR4, MyD88, and NF-κB that is triggered by LPS by preventing the degradation of the inhibitor (Xueqin, et al., 2014). Numerous models of autoimmune and allergy diseases have been used to investigate the anti-inflammatory properties of artemisinin and its derivatives. It has been found that rheumatoid arthritis (RA) experimental models can be protected against by artesunate, dihydroartemisinin, artemether, and the water-soluble derivative SM905 (Cuzzocrea, Saadat, Paola, & Mirshafiey, 2005)(Mirshafiey, Saadat, Attar, Paola, Sedaghat, & Cuzzocrea, 2006)(J-X, et al., 2008)(Yanmei, et al., 2013).

Antibacterial activities and Antifungal activities

Artemisia annua have volatile compounds which shows antibacterial and antifungal activities. With the help of its volatile and main components (i.e. camphor, alpha-pinene, camphor, 1,8-cineol and Artemisia ketone) different test were performed. (Bilia, Santomauro, Sacco, Bergonzi, & Donato, 2014). Through hydrodistillation, Artemisia annua tested with the gram-positive bacteria volatile organic compounds were Staphylococcus aureus, Enterococcus hirae, Enterococcus faecalis, Streptococcus pneumonia, Micrococcus luteus, Bacillus cereus, Bacillus subtilis, Bacillus spp., and Listeria innocua. For the gram-negative bacteria, Escherichia coli, UPEC-Uropathogenic, Escherichia coli ETEC-Enterotoxigenic, Escherichia coli EPEC-Enteropathogenic, Escherichia coli EIEC Enteroinvasive, Escherichia coli STEC-Shiga-toxin producer, Shigella sp., Salmonella enteritidis, Klebsiella pneumoniae, Haemophilu influenzae, and Pseudomonas aeruginosa were tested. (Stojanovic, et al., 2019)(Yan, H.-B, X.-D, & J.-H., 2011)(Juteau, Masotti, Bessiere, Dherbomez, & Viano, 2002)(M.R, 2009)(Massiha, Khoshkholgh-Pahlaviani, Issazadeh, Bidarigh, & Zarrabi, 2012)(Viuda-Martos, et al., 2010)(Duarte, Leme, Delarmelina, Soares, Figueira, & Sartoratto, 2006) Fusariumoxysporum, Fusariumsolani, and Cylindrocarpondestrutans are frequent agricultural fungal pathogens that cause root rot disease in the cultivation of plants, including medicinal materials and crops. Artemisia annua extracts have antifungal action against these pathogens. This study demonstrated the broad spectrum of antifungal effects of a coumarin derivative found in the herb Artemisia annua that has an extra acetyl group connected to C-6.

The oil component with the strongest antibacterial action is artemisia ketone. In actuality, at extremely low concentrations (range 0.07–10 mg/mL), it proved to be effective against bacteria and several fungus (*C. albicans and A. fumigatus*). Additionally, the essential oil's antifungal efficacy against commercially significant tomato foliar and soilborne fungal infections was assessed. Verticillimdahliae, *Botrytis cinerea*, Phytophthorainfestans, and Sclerotiniasclerotiorum were all susceptible to the essential oil's effects (Soyle, et al., 2005).

Other Protozoa activities

The antitozoan parasites, such as Leishmania spp., Trypanosoma spp., Toxoplasma gondii, Neosporacaninum, Eimeriatenella, Acanthamoebacastellanii, Naegleriafowleri, *Cryptosporidium parvum*, *Giardia lamblia*, and Babesia spp., that artemisinin and its derivatives are active against both in vitro and in vivo (Loo, Lam, Yu, Su, & Lu, 2016).

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Amoebae were impacted by the pure artemisinin preparation 100–300 times more potently than by the examined extracts. Chloroform extract was the most effective anti-amoebic extract.

Antiviral activities

The antiviral properties of artemisinin and its derivatives, as well as the extract from Artemisia annua, have been demonstrated both in vitro and in vivo. RNA and DNA viruses have both been tested. (Efferth, Beyond malaria: The inhibition of viruses by artemisinin-type compounds, 2018). The syncytium inhibition assay, which is based on the interaction between the HIV-1 envelope and the CD4 cell membrane protein on T-lymphocytes, was used to test a methanolic extract of *Artemisia annua* (Young-Sa & Eun-Rhan, 2003). Artemisia annua tea infusion has been demonstrated to have anti-HIV properties in an in vitro investigation. The anti-HIV potential of folksy including *Artemisia annua* and *Artemisia afra* used to treat malaria has come under scrutiny due to the co-occurrence of HIV and malaria in malaria endemic areas. Artemisinin was not the primary chemical by which these plants exhibited their anti-HIV properties, as has been quickly shown.Strong inhibitory effects are seen against double-stranded DNA viruses, such as CytoMegaloVirus (CMV), Herpes Simplex Virus 1 (HSV-1), Human Herpes Virus 6A (HHC-6A), and Epstein-Barr Virus (EBV), by artemisinin and its derivatives from the plant *Artemisia annua*, especially artesunate(Efferth, Romero, wolf, Stamminger, Marin, & Marschall, 2008)(Milbradt, Auerochs, Korn, & Maeschall, 2009).Both the ganciclovir-resistant and susceptible strains of HCMV were stopped from replicating by the artemisinin derivative artesunate. (Efferth, et al., 2002)When compared to artesunate, artemether, dihydroartemisinin, or ganciclovir, all of the compounds were extremely active and had very low IC50 values (Flobinus, et al., 2014)(Arav-Boger, et al., 2010)(Ran, Mott, Rosenthal, Genna, Posner, & Arav-Boger, 2011)(Reiter, et al., 2015).The medication to attach to NF-κBRelA/p65, hence preventing HCMV-induced NF-κB activation in the cell(Hutter, et al., 2015).The significance of the anti-HCMV action of artemisinin and its derivatives was also highlighted by the utilisation of combination therapy approaches to combat ganciclovir-resistant (HCMV) Human cytomegalovirus. Patients who experienced cytomegalovirus (CMV) infection-related problems following hematopoietic stem cell transplantation had these combinations. Within ten days, oral administration of artesunate (100 mg/d) isolated from *Artemisia annua* led to enhanced hematopoiesis and a fast reduction in viral load (1.7 to 2.1 log reduction) in whole blood (Shapira, et al., 2008).Additionally, artesunate was assessed using Human Herpes Simplex Virus 1 (HSV1).When valacyclovir is used in combination with other medications, pro inflammatory cytokines (IL-1β, IL-2, IL-6, IFN-γ) and chemokines (CCL2, CCL4, CCL6) are reduced. It has also been demonstrated that artesunate works well to prevent the hepatitis B virus (HBV) from replicating (F H, et al., 2013). Artesunate suppressed the polyomavirus BK (BKV) infection in human primary proximal tubular epithelial cells, according to DNA viruses. The amounts of extracellular (Polyomavirus BK) BKV DNA, which indicate the formation of viral progeny, decreased in a concentration-dependent way. Hepatitis B virus (HBV) replication has also been demonstrated to be effectively inhibited by artesunate. In vitro, artesunate was reported to decrease (Hepatitis B virus) HBV-DNA levels with an IC50 value of 0.5 µM and suppress HBV surface antigen (HBsAg) secretion with an IC50 value of 2.3 µM (Bhise, Agarwal, Thakur, Akshay, Cherian, & Lole, 2023). range lower than the ~ 7 µM plasma medication concentration needed for anti-malarial therapy (Batty, Davis, Thu, Binh, Anh, & Ilett, 1996).

Antitumor activities

Numerous other physiologically active compounds have been found in *Artemisia annua* (Lang, et al., 2019)(Ferreira J. F., Luthria, Sasaki, & Heyerick, 2010)(Huahong, et al., 2009), indicating that this plant may provide novel herbal anticancer treatments. There is anticancer efficacy in vitro and in vivo for *Artemisia annua* extract devoid of artemisinin, along with known active components. Two in vivo cancer models, the orthotopic breast cancer xenografts in nude mice and the chick chorioallantoic membrane (CAM) assay, were used to validate in vitro data. The breast (MDA-MB-231 and MCF-7), pancreas (MIA PaCa-2), prostate (PC-3) and non-small lung cell (A459) cancer cells were all shown to be less viable by the *Artemisia annua* extract. Similarly, the most prevalent components of the extract—chrysosplenol D, arteannuin B, and casticin—inhibited the viability ofMDA-MB-231 breast cancer cells. In vivo, the extract caused apoptosis in triple negative breast cancer (TNBC), reduced tumour growth, and inhibited the proliferation of cancer cells. Nuclear chromatin breakage and cytoplasmic condensation caused SMMC-7721 hepatocarcinoma cells to undergo apoptosis when exposed to an essential oil extracted from *Artemisia annua* at a concentration of 100 µg/mL (Taleghani , Emami, & Tayarani-Najaran, 2020).

The anticancer actions of artemisinin and its derivatives have been linked to specific modes of action (Efferth, From ancient herb to modern drug: *Artemisia annua* and artemisinin for cancer therapy, 2017). The endoperoxide moiety is essential for the bioactivity of medications of the artemisinin type, indicating that the oxidative stress response plays a significant role. Its cleavage results in the production of reactive oxygen species (ROS) and most likely oxidative damage. In a dose-dependent way, artemisinin causes oxidative DNA damage (Qiang, et al., 2015). Reactive Oxygen Species and oxidative DNA lesions have a profound impact on cellular integrity. They create disruptions in the processes involved in cellular division and replication, which in turn result in cell cycle arrest and cell death. The same process applies to medications of the artemisinin class. There have been reports of cell cycle stoppage at the G1 or G2 stages. Artemisinin can induce apoptosis through both the extrinsic pathways regulated by FAS receptors and the mitochondrial (intrinsic) pathways. Non-apoptotic cell death mechanisms such autophagy, necrosis, necroptosis, oncosis (ischemic cell death), anoikis (anchorage-dependent cell death), and ferroptosis are among the other cell death mechanisms that artemisinin-type medicines cause in tumour cells. Ferrous iron has been shown to increase the cytotoxicity of medications of the artemisinin type against tumour cells, and it has been shown that artemisinin and its derivatives are closely associated with ferroptosis, a sort of iron-dependent cell death (Ooko, et al., 2015)(Renyu, et al., 2016).

RESULT AND DISCUSSION

The present article reviews a details study on a details ethno botanical study of *Artemisia annua* and its pharmacological benefits.

Conclusion

It can be stated that traditional Indian medicinal plants have a history of use as herbal treatments. Many Indian plant species have been studied for their ability to treat cognitive problems. The plant *Artemisia annua* is found all over the world. It is among the most significant plants utilised in African and Chinese traditional medicine. After much research, *Artemisia annua* has demonstrated encouraging anti-plasmodial, antiviral, antibacterial, anticancer, anti-inflammatory, and antioxidant properties. Research indicates that artemisinin is the plant's active ingredient, particularly for its ability to combat malaria. Artemisinin production possesses comparable anti malarial characteristics to *Artemisia annua*. The substances found in the two species will be taken into account, together with the results of in vitro and in vivo studies. Natural products can help prevent and treat a variety of neurodegenerative disorders and neuronal impairments. Plant-derived compounds such as polyphenolics and alkaloids have the potential to decrease the progression of neurodegeneration while also improving memory and cognitive functioning. Although the different extract of the plant has pharmacological importance but medicinal application and clinical application can be made only after extensive research on its bio-activity, mechanism of action, pharmacotherapeutics and extensive safety studies. It also requires to research on pharmacognostical, phytochemical and pharmacological aspect. However, research going on it would be easier to develop new drugs after extensive studies on mechanism of action & pharmacological effects. It is expected that it may find application as a novel herbal drug to control various diseases.

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