World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(REVIEW ARTICLE)

A systematic exploration of pharmacological attributes and phytochemical components in *Euphorbia hirta Linn*: A mini review

Sengottuvelu S, Sibi K *, Angelin Staffin S, Rajasimman V, Dheebhenthiranath D, Anandhan D and Chella Prakash C

Department of Pharmacology, Nandha College of Pharmacy, Koorapalayam Pirivu, Pitchandampalayam (P.O.), Erode, Tamilnadu, India, Pin – 638 052.

World Journal of Biology Pharmacy and Health Sciences, 2023, 16(03), 200–212

Publication history: Received on 05 November 2023; revised on 20 December 2023; accepted on 23 December 2023

Article DOI: https://doi.org/10.30574/wjbphs.2023.16.3.0507

Abstract

In several nations, including India and China, herbal medications are integral parts of traditional medicine. India is home to the well-known medicinal system known as Ayurveda. For thousands of years, Ayurveda, Siddha, and Unani, three of India's traditional medicinal systems, have been used. Herbal medicines are the earliest known forms of human healing. India is well-known around the globe for its Ayurvedic medicine. *Euphorbia hirta* has been traditionally used to treat a variety of conditions, including gonorrhea, diarrhea, jaundice, acne, worm infestations in youngsters, feminine diseases, and digestive issues and tumors. The white milky latex of this plant has an incredible health impact on human health. Alkanes, triterpenes, phytosterols, tannins, polyphenols, and flavonoids are all said to be present. This mini-review of the data collection of the past ten years, presents the traditional uses, chemical constituents, medicinal properties, and some future aspects to promote the use of *E. hirta* in the improvement of human health.

Keywords: *Euphorbia hirta*; Traditional use; Phytoconstituents; Pharmacological activity

1. Introduction

Herbal medicines are essential factors of traditional drugs in several countries including India and China. Ayurveda is a famed medical system that began in India. Three of India's indigenous medical systems Ayurveda, Siddha, and Unani have been rehearsed for numerous glories [1]. Certain Ayurvedic specifics that treat present-time affections are now accessible in the request. Multitudinous undetermined health issues in contemporary society can be addressed by Ayurveda and other conventional natural remedies, and they can serve as an original base for the advancement of new specifics. Over 80 of the individualities in husbandry that are developing warrant the fiscal means to pay for veritably abecedarian health services, specifics, and immunizations [2]. The cost of contemporary drugs has become unattainable. With newer technology decreasingly percolating medical opinion and operation, it'll come more so, the maturity of these advancements hasn't gone through evaluations, and of those that have, some of them unintentionally failed to live up to the expectation and in some cases have indeed done less.

Roughly 80% of people on the earth are allowed to not have access to contemporary medical care. Indeed, in the modernized West, about half of the remaining people who have permitted the application of contemporary healthcare would be more inclined to use an indispensable system [3]. The application of herbal remedies has greatly increased over the once many decades as a result of antimicrobial resistance, the negative goods of contemporary specifics, and the ineffectiveness of contemporary treatments for habitual ails. It's projected that indigenous drug account for roughly 75% of the factories- grounded remedial realities used encyclopedically. Roughly 70% of contemporary specifics are set up in India thanks to natural coffers, and several further synthetic coequals have been created using plant-grounded

* Corresponding author: Sibi K

prototype composites [4] thus, to help similar issues and offer universal access to introductory healthcare, the globe is searching for further affordable, readily available, better physiologically compatible traditional medical systems, and holistic approaches. With nearly 2000 species, the rubric *Euphorbia*' spurges, Euphorbiaceae is the group with the third largest among flowering shops. mortal interest in it dates back thousands of times, drawn by its worldwide distribution and remarkable diversity of growth forms. According to, members of *Euphorbia* are fluently linked by their milky latex and technical inflorescences known as cyathia. The species *E. milii DesMoul*., *E. tirucalliL*., and *lactea Roxb*. are well-known for their aesthetically pleasing and ménage uses [5]. Also, some species, like *Euphorbia antisyphilitica Zucc*.' candelilla wax and *E. intisy Drake'* intisy rubber, served economically from their latex. numerous *Euphorbia* species are familiar to people and medical systems far and wide they do because of the biologically exceptionally active natural products set up in the latex [6]. The plant has been also used in bowel complaints, worm infestations, order monuments, and low milk yield. The whole plant has also been reported to retain anti-bacterial, anti-amoebic, anti-fungal, anti-viral, spasmolytic, anti-diarrheal, dreamy, anxiolytic, analgesic, antipyretic, anti-inflammatory, anti-malarial and anti-hypertensive parcels. The thing of this review is to give a summary of *Euphorbia hirta*'s chemical factors and named pharmacological goods for the last ten times.

2. Botanical Description

Euphorbia hirta Linn. is a member of the Euphorbiaceae family and is generally set up growing along highways, in grassy areas, and on vacant land areas, generally known as" asthma weed" or" tawa- tawa," and is native to tropical and tropical regions around the world. Its precise place of origin isn't definitively known due to its wide distribution and naturalization in numerous countries. still, it's believed to have begun in Asia, conceivably in India or Southeast Asia. *Euphorbia hirta* has a long history of traditional use in colorful Asian countries, including India, where it has been employed for its medicinal parcels in folk drugs. It has also naturalized in another corridor of the world, similar to the Philippines, Africa, and the Americas, where it's frequently considered a rampant species due to its capability to grow roundly and contend with cultivated crops. The plant's rigidity and capacity to thrive in a variety of environmental conditions have contributed to its broad distribution and naturalization in different regions. Its traditional uses and implicit medicinal parcels have made it a subject of interest in both traditional and ultramodern herbal drugs. One of *Euphorbia hirta*'s main features is its upright, thin stems, which can reach heights of 40 – 60cm. The plant appears nearly squishy due to the fine hairs covering the interspersing arrangement of leaves along the stem. Little inflorescences of *Euphorbia hirta*'s greenish-white flowers are grouped, and the plant also yields bitsy, three-lobed seed capsules. The shops are characterized by the presence of milky latex and the detailed description shown in Table 1. The excerpt of *E. hirta* has a dreamy effect on the mucous membrane of the respiratory and genital-urinary tract. *E. hirta* demonstrated its antimicrobial implicit pathogens, which are intertwined in a variety of mortal conditions. The root decoction is used to treat complications, patient diarrhea, and puking. In addition to treating snake mouthfuls, blisters, injuries, and boils, root decoction also helps nursing mothers whose milk force is shy. The whole plant, which is regarded as haemostatic, dreamy, and slumberous, is specified as a cure. *E. hirta* is most constantly used in Australia to treat pectoral complaints, asthma, oedema, and hypertension [7]. Expansive reports have demonstrated that the entire plant exhibits a 45 immunomodulatory exertion through the inhibition of nitric oxide product [8]. The traditional use of *E. hirta* reported that its methanolic excerpt could fully help the toxin caused by *Naja naja* venom in both *in-vitro* and *ex-vivo* settings [9] and traditional use of the plant is shown in Figure 6.

Table 1 Description of plant parts

Plant parts	Description	Reference
Leaf  **Figure 1** Leaf of *E. hirta*	The leaves (Figure 1) were arranged in opposite pairs along the stem. Typically, the leaves are small, elliptical, and have serrated margins. Their measurements are 2cm in width and 5cm in length. The leaves were rough to the touch and had fine hairs. The age of the plant can affect its color, which can range from green to crimson. The venation is pinnate with prominent midribs and lateral veins. It may have small stipules at the base of the leaves.	[10]
Flower		

 **Figure 2** Flower of *E. hirta*	It produces small, unisexual flowers (Figure 2) in clusters, surrounded by specialized bracts. These bracts, often brightly coloured, can be mistaken for petals. They are held above foliage, making them more noticeable. *E. hirta* can produce flowers year-round, but the blooming season may vary based on environmental conditions. The ovary is superior and has three angular, sparsely pilose locules.	[11]
Stem  **Figure 3** Stem of *E. hirta*	It is a bushy plant with a green or reddish-brown stem (Figure 3), often covered with fine hairs. It has a prostrate growth habit and may become woody at maturity. Like other Euphorbia species, it produces white latex from cut or broken stem parts.	[12]
Fruit  **Figure 4** Fruit of *E. hirta*	*Euphorbia hirta* produces small, three-lobed capsules (Figure 4), typically green but browning as they mature, containing seeds. These capsules, ranging from 2 to 4 millimeters in diameter, split open to release seeds.	[10]
Root  **Figure 5** Root of *E. hirta*	The root (Figure 5) of *Euphorbia hirta* is typically fibrous and slender. It extends from the base of the stem and can penetrate the soil to varying depths. The root system aids in anchoring the plant and absorbing nutrients and water.	[13]

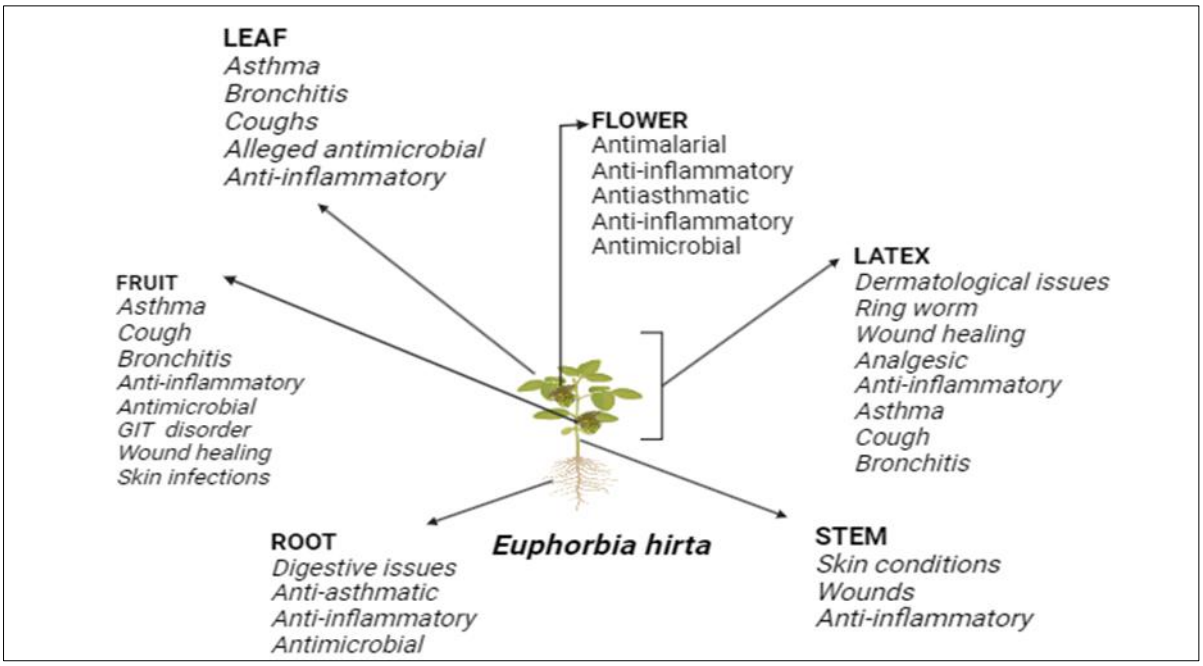

Figure 6 Traditional uses of *Euphorbia hirta*

3. Phytochemical Screening

Phytochemical screening is a process used to identify and assay the presence of colorful bioactive composites in plant extracts. Shops contain a different array of chemical composites, frequently appertained to as phytochemicals, which contribute to their medicinal, nutritive, and natural parcels. Phytochemical webbing involves a series of tests to descry the presence or absence of specific substances. The study was delved by Karki S *et al*. on the phytochemicals in *Euphorbia hirta* plant excerpts using FTIR and GCMS analysis. primary webbing revealed flavonoids, alkaloids, saponins, tannins, proteins, carbohydrates, Quinones, fats, and canvases. FTIR spectroscopy revealed colorful composites. GC- MS analysis linked fifteen composites, with glycol aldehyde dimer as the main chemical element. The methanol excerpt showed significant phytochemical parcels [14]. Dhanapal V *et al*. conducted an original phytochemical study and TLC biographies to impose the characteristics of the leaves and stem of *E. hirta*. They set up that the presence of steroids, carbohydrates, flavonoids, proteins, alkaloids, and saponin was revealed by the primary phytochemical screening [15]. To investigate the phytochemicals in *E. hirta*, Basyal D *et al*. Color responses were used for phytochemical screening after the dry grease paint had been uprooted. The Folin-Ci and aluminium chloride ways were used to determine total flavonoid content [TFC]. The phenolic composites and flavonoids have anti-inflammatory and antioxidant parcels, which might regard for some pharmacological goods and traditional operations of *E. hirta*. [16]. Colourful birth styles were performed by Bhat SA *et al*. in 2019 to study the phytochemicals of *E. hirta* and were screened for ingredients like sugars, saponins, flavonoids, tannins, and glycosides in which the methanolic excerpt of *E. hirta* was the suitable detergent birth and revealed the presence of alkaloids, tannins, glycosides, and saponins [17]. The ash flyspeck value, extractive value, total humidity content, and luminescence analysis of *Euphorbia hirta*, a plant with well-known remedial rates, were examined. The powdered plant material had an 8.92% ash value, a 7.0% water answerable excerpt, a 4.86% ethanol answerable excerpt, a 9.71% methanol answerable excerpt, and a 9.85% humidity content. The analysis observed different phytochemical rudiments in three excerpts. Secondary metabolites set up in the ethanolic and methanolic splint excerpts included proteins, lipids, canvases, epoxies, bonds, alkaloids, flavonoids, terpenoids, tannin, phenol, steroids, glycoside, saponin, and coumarin. Carbs, proteins, amino acids, tannin, phenol, steroids, saponin, and anthraquinone were each present in the waterless excerpt. Ahmad W *et al*. looked into the phytochemical webbing of excerpts from *E. hirta* in another disquisition. Alkaloids, flavonoids, saponins, terpenoids, steroids, and sterols have been linked by phytochemical webbing in the excerpts of the upstanding section of *E. hirta*.

4. Pharmacological Properties

Euphorbia hirta has captured attention for its multifaceted pharmacological conditioning. Fuelled by composites like flavonoids and tannins, the plant exhibits anti-inflammatory exertion, holding the eventuality for easing seditious conditions. Its antimicrobial attributes extend to bacteria, fungi, and contagions, showcasing a broad diapason of

exertion. *Euphorbia hirta*, rich in antioxidants, contributes to combating oxidative stress, vital in colorful healthy surroundings. Beyond its literal use for respiratory conditions, recent studies emphasize bronchodilator goods, intimating at anti-asthmatic operations and the reported activities were tabulated in Table 2. The condiment's versatility extends to addressing gastrointestinal issues, including its traditional use for diarrhea. Studies into antidiabetic eventuality and crack-mending parcels add layers to its pharmacological profile. While primary exploration introduces the interesting possibility of anticancer conditioning, comprehensive studies are imperative. *Euphorbia hirta*'s pledge in different pharmacological disciplines necessitates rigorous scientific scrutiny to establish efficacity and safety for implicit clinical integration. As with any herbal remedy, consulting healthcare professionals remains pivotal to informed and responsible medicinal use.

4.1. Antioxidant Activity

Antioxidants are those substances that shield cells from the dangerous goods of free revolutionaries. Antioxidants may have a circular impact on several degenerative conditions, including cancer and heart complaint since free revolutionaries are constantly linked to these conditions Neelesh Sharma *et al*. 2014 assessed the anti-inflammatory, antioxidant, and anti-cancer goods of the ethanolic excerpt for *E. hirta*. The exertion of DPPH radical scavenging was assessed with an ESR spectrometer. The DPPH-scavenging exertion of the *E. hirta* ethanol excerpt 0.5mg/ml was 61.18 ±0.22, whereas the ascorbic acid positive control [0.4mg/ml] demonstrated 100 ±0.22% activity [18]. The antioxidant exertion of *E. hirta* leaves, stems, roots, and flowers has been delved by Aziana Ismail *et al*. in 2019. The total phenolic content, flavonoid content, and *in- vitro* antioxidant exertion of the methanolic excerpt of *E. hirta* were assessed using the DPPH assay and the methanolic excerpt of *E. hirta* demonstrated 99.77±0.16 $P<0.05$ of DPPH interdict at an attention of 1.0mg/ml. When 0.25mg/ml of *E. hirta* methanolic excerpt was used, a better reduction of scavenging exertion was seen, with inhibition of DPPH of 89.17 $P<0.01$ [19]. In 2020, Ngan Tran *et al*. used the maceration system to establish the DDPH radical scavenging exertion of methanol, petroleum ether, chloroform, ethyl acetate, butanol excerpts of *E. hirta* and set up that ethyl acetate was the most potent antioxidant, with IC_{50} values of 10.31 ±0.01µg/ml and 1.47 ±0.12µg/ml [20]. Abu Arra Basman 2011 *et al*. delved the antioxidant effect of the methanolic excerpt of *E. hirta* and set up that at 1mg/ml, the methanolic excerpt of *E. hirta* leaves demonstrated the highest DPPH scavenging exertion. The flowers, roots, and stems showed the smallest DPPH scavenging activity they were 52.45±0.66%, 48.59%, and 44.42±0.94% [21].

S Asha *et al.* 2016 carried out antioxidant activity of both ethanolic and methanolic extracts of the leaves of *E. hirta* by 1,1- diphenyl-2-picrylhydrazyl [DPPH] assay, superoxide anion scavenging assay and hydroxyl radical scavenging assay and the findings indicated that the ethanol extract had the highest yield of extraction, total content of flavonoids and phenols, and highest activity in every test conducted on antioxidant assays. These outcomes demonstrated that the extracts acquired It was discovered that a polar solvent had maximum activity when compared to other derived extracts [22].

In 2019 P.N. Mekam *et al*. illustrated the antioxidant properties of water and ethanolic fractions of *E. hirta,* and to test the radical scavenging capacity, the ABTS assay was employed. When it came to scavenging ABTS and superoxide anion radicals, the ethanol extract of *E. hirta* leaves outperformed the corresponding water extract $P < 0.05$ despite the LC-MS analysis showing a lower phenolic content [23]. The *E. hirta* leaf ethanol extract was superior to the corresponding water extract in terms of effectiveness scavenging superoxide anion radicals $P < 0.05$ and ABTS $P < 0.05$, despite the LC-MS analysis showing a lower phenolic content.

Savita Jakhar *et al*. discussed the antioxidant effect, using a Soxhlet apparatus, the powdered plant material was extracted using Petroleum ether, ethanol, water, and acetone as four different solvents, and the ability of *E. hirta* crude plant extracts to scavenge free radicals was examined. Aqueous extract was most efficient at scavenging free radicals, followed by extracts from acetone, ethanol, and petroleum ether. Petroleum ether, ethanol, water, and acetone were used to extract the plant material. Likewise, the lowest IC_{50} value 105.39µg/ml was attained using aqueous extract, then by acetone extract [371.0], extract 504.92µg/ml, and extract from petroleum ether 645.12µg/ml [24].

Olaoluwa *et al*. 2018 used n-hexane to isolate the essential oils from the aerial parts of *Euphorbia hirta* by all glass Clevenger-type apparatus and showed that *E. hirta* exhibited greater antioxidant activity than α-tocopherol, with percentage inhibition ranging from 15.7-19.7% at concentrations between 3.125-100% [25].

Dolly Kain *et al*. 2022 investigated *E. hirta* antioxidant properties. The plant's leaves were sun-dried, and then processed using a mixer grinder to a powder before being extracted using the Soxhlet technique. With respect to scavenging free radicals, the plant's ethanolic extract exhibited a remarkable capacity, as evidenced by activity percentages of 25.615%, 56.32%, 60.45%, 62.97%, and 68.505% at concentrations of 100, 250, 500, 750, and 1000µg/ml, in that order [26].

Basyal *et al.* evaluated the antioxidant activity using the DPPH free radical scavenging assay, the antioxidant activity IC_{50} of the ethyl acetate extract from the aerial parts of *E. hirta* was determined to be 32.23µg/ml [27].

4.2. Anti-inflammatory Activity

Inflammation is the complex biological response of vascular tissues to harmful substances such as pathogens, irritants, or damaged cells. It can be classified as acute or chronic and involves a sequence of biochemical reactions involving the immune system, the local vascular system, and different cell types present in the wounded tissue. The first response, referred to as acute inflammation, is characterized by an increase in plasma levels in the blood as well as the movement of innate immune system cells, such as neutrophils and macrophages, into the injured tissues. A progressive alteration in the type of cells present at the location of the inflammatory reaction is linked to chronic inflammation, which is characterized by the simultaneous destruction and healing of the wounded tissue.

Numerous bioactive chemicals that are included in the composition of *E. hirta* are responsible for its therapeutic qualities. These comprise tannins, alkaloids, flavonoids, and other secondary metabolites, all of which support the medicinal properties of the plant. Numerous investigations into the processes underpinning this plant's anti-inflammatory properties have been carried out by researchers, providing fascinating new insights into the possible uses of this plant in contemporary medicine.

Studies examining *E. hirta* impact on inflammatory pathways have demonstrated its ability to modulate key components of the immune response. One mechanism involves the scavenging of pro-inflammatory cytokines, which play a pivotal role in promoting inflammation. By suppressing the release or activity of these cytokines, *E. hirta* may contribute to dampening the overall inflammatory response in the body.

In addition to cytokine modulation and antioxidant effects, *E. hirta* is believed to interfere with inflammatory signaling cascades. These cascades involve a series of molecular events that amplify the inflammatory response. By disrupting or modulating these pathways, the plant may exert a regulatory influence on inflammation, potentially offering therapeutic benefits in conditions where excessive or chronic inflammation is a contributing factor.

The anti-inflammatory potential of *E. hirta* has significant implications for various health conditions, including inflammatory joint disorders like arthritis and respiratory conditions such as asthma. As research in this field progresses, there is growing interest in harnessing the plant's bioactive compounds for the development of novel anti-inflammatory agents. The exploration of *Euphorbia hirta's* pharmacological properties exemplifies the ongoing search for natural sources of therapeutic compounds and highlights the potential of traditional medicinal plants in addressing contemporary health challenges**.**

The anti-inflammatory effect of *E. hirta* ethanolic extract on LPS-induced NO levels in mouse macrophages RAW 264.6 cells have been studied by Neelesh Sharma *et al*. in 2014. It was discovered that the extract contained a number of anti-inflammatory compounds, such as 5-HMF, MA, and others that were demonstrated to inhibit NO production, which is the source of the extract's anti-inflammatory properties [18].

Jocelyn Chen *et al.* 2015 carried out PGE_2 inhibiting effect in rabbit synovial fibroblasts cells HIG-82 as the aqueous extract possessed the highest activity among all other extracts. Phorbol myristate was used to activate Rabbit synovial fibroblasts cells HIG-82 and then treated with the fractions. More than the other crude aqueous extracts, the aqueous extract suppressed the generation of PGE2 [27].

In a 2018 study, Xia *et al*. discovered that the ethanolic extract of *E. hirta* has anti-inflammatory effects on newborn asthmatic rats. Compounds include pentacyclic acid, ethyl linoleate, 1,2,3-trihydroxy benzene, gamma-tocopherol, squalene, and 9,12,15-octadecatrien1-ol are present in the extract. While antioxidant levels increased, the extract decreased total leukocytes, eosinophils, tumour necrosis factor-α, interleukin IL-6, and lipid peroxidation. Additionally, the extract decreased the levels of mRNA expression for Bax, p53, TNF-α, IL-6, cyclooxygenase-2, caspase-3, and nerve growth factor precursor. Additionally, the study discovered that mice treated with a methanolic extract of *E. hirta* leaves shown anti-inflammatory effects granulomas and ear oedema were significantly reduced at doses of 200, 400, and 800mg/kg.

Deepak Basyal *et al.* 2020 studied the methanolic extract of *Euphorbia hirta*'s upper parts' gives an anti-inflammatory property. Denaturation of proteins in-*vitro* bioassay was used to investigate anti-inflammatory activity. Diclofenac sodium, a common anti-inflammatory medication, demonstrated a maximum inhibition of 91.28% at 1000µg/ml when compared to the control, while extract showed a maximum inhibition of 68.20 at 1000µg/ml when compared to the

control. The anti-inflammatory activity of the extract was equivalent to that of the reference drug and standard diclofenac sodium extract because there was no statistically significant difference between the two p>0.05 [26].

Upadhyay *et al.* 2014 examined the pro-inflammatory cytokine production of RAW246.7 macrophages about the anti-inflammatory effect of the methanolic extract of *E. hirta* and its correlation with an *in-vivo* inflammatory paw oedema model. In LPS-induced macrophages, methanolic extract of *E. hirta* cyclooxygenase COX and nitric oxide synthase NOS-mediated synthesis of prostaglandins E-2 PGE-2 and nitric oxide NO was suppressed. The anti-inflammatory properties of methanolic extract of *E. hirta* are correlated with a dose-dependent decrease in the production of pro-inflammatory cytokines. The in-vitro anti-inflammatory results were correlated with the *in-vivo* evaluation of carrageenan-induced Wistar rat paw oedema, as the 500mg/kg b.w. concentration showed an anti-inflammatory effect similar to that of the reference non-steroidal diclofenac 10mg/kg b. w. [30].

Mei-Fen Shih *et al*. 2010 used β-amyrin from *E hirta's* ethanolic extract to study the anti-inflammatory properties of the plant in lipopolysaccharide LPS-induced RAW 264.7 cells. They measured the generation of nitric oxide NO and the expression of iNOS protein and mRNA using western blotting, RT-PCR, and a colorimetric test. PGE2, TNFα, and IL-6 level variations were tracked using ELISA. The findings demonstrated that *E. hirta* inhibited LPS-induced NO generation in a dose-dependent manner without causing cytotoxicity and had a notable anti-inflammatory impact through its active ingredient, β-amyrin [31].

4.3. Anti-cancer Activity

Euphorbia hirta, has recently attracted considerable attention for its potential anti-cancer activity, adding a compelling dimension to its pharmacological profile. Cancer, characterized by uncontrolled cell growth, remains a global health challenge, prompting researchers to explore novel therapeutic agents from natural sources. *E. hirta*, with its rich history in traditional medicine, is now under scientific scrutiny due to the presence of bioactive compounds that may impart anti-cancer effects.

Studies have indicated that *E hirta* may harbor compounds with properties that could inhibit the growth of cancer cells or induce their apoptosis programmed cell death. The plant's anti-cancer potential may be linked to its diverse array of phytochemicals, including flavonoids, alkaloids, and terpenoids, which have demonstrated anti-tumour activities in various experimental models.

Understanding the anti-cancer properties of *E. hirta* not only contributes to the expanding knowledge of natural remedies but also holds the potential for the development of novel cancer treatments. Neelesh Sharma *et al*. 2014 found that the ethanolic extract significantly and dose-dependently increased the death of cancer cells when E. hirta extract 50, 100, and 200µg/ml was incubated with Acute Myeloid Leukaemia Cell Line HL-60 4 × 104 cells/ml in a 96 well plate at 37 °C for 24 h. Cell viability was assessed using the MTT test. According to their results, DDMP made up 2.54% of the GC-MS study's surface and might be involved in *E. hirta* anticancer properties [18].

P. Anitha *et al*. 2014 employed standard MTT colorimetric and Trypan Blue preliminary screening methodologies to test the cytotoxicity of an ethanolic leaf extract of *E. hirta* utilizing Ehrlich Ascites Carcinoma EAC and Dalton Lymphoma Ascites DLA cell lines. The leaf extract from *E. hirta* was found to be more cytotoxic against Ehrlich Ascites Carcinoma cell lines, demonstrating 59.67% cytotoxicity against them when compared to cytotoxic activity against Dalton Lymphoma Ascites cell lines. An extract from *E. hirta* showed a dose-dependent reduction in proliferation and induction of apoptosis in carcinoma cell lines. Strong cytotoxic action was shown by the ethanolic leaf extract of *E. hirta* against DLA and EAC cell lines; the extract's IC_{50} values were found to be 560.83mg/ml and 384.7mg/ml, respectively [32].

Sulaiman *et al.* 2023 reported the Anti-cancer activity of the Alcoholic extract of *E. hirta* using the Ehrlich Ascites Carcinoma model in mice using conventional 5-fluorouracil as standard. There was a (% ILS) 52.9% increase in survival time with the high dose of *E. hirta* Comparing the high-dose treated animals with *E. hirta* to the control group 'MST-25.5 days, the MST for these animals was 39.0 days. The previously mentioned outcomes are parallel to standard 5-fluorouracil ILS-98.7% and MST-50. 7 days. *E. hirta* significantly reduced the incidence of EAC-induced peritoneal ascites in mice by exhibiting dose-dependent anticancer activity [33].

Vijayapriya *et al.* 2021 evaluated the methanolic extract of the leaf *E. hirta*. For its *in-vitro* Anti-proliferative activity. At concentrations of 50µg/ml and 350µg/ml, respectively, the plant's methanolic extract demonstrated significant dose-dependent antiproliferative activity against the MG63 cell line 24 h [34].

RajaKumaran Subhashini *et al.* 2021 investigated the Anti-proliferative effects of methanolic extracts of *E. hirta* leaves on the MG63 cell line. The plant's methanolic extract demonstrated notable dose-dependent antiproliferative activity against the MG63 cell line, with concentrations ranging from 50µg/ml to 350µg/ml showing the greatest range of activity at 24 h. Furthermore, a dose-dependent reduction in cell viability was observed with the plant [35].

Prashant Y Mali *et al*. 2017 investigated the cytotoxicity of *E. hirta* methanolic extract against NCIH-522 and the Vero cell line. The cytotoxicity of the methanolic extract of *E. hirta* was examined using an MTT test. The medicine used as the standard reference was doxorubicin. The experiment used Doxorubicin with extract concentrations ranging from 1000 to 0.05µg/ml. The results of the current investigation demonstrated that the 50% cell growth inhibition IC_{50} of the methanolic extract of *E. hirta* and doxorubicin against the NCIH-522 cell line was 466.13µg/ml and 531.14µg/ml and that it was 1375.22µg/ml and 2392.71µg/ml against the Vero cell line. It was found that the NCIH-522 and Vero cell lines were hazardous to methanolic extract. It is caused by the presence of phytocompounds in the toxic class, as shown by the FTIR spectrum [36].

4.4. Anti-ulcer Activity

E. hirta, has garnered attention for its potential anti-ulcer activity, marking a significant aspect of its pharmacological profile. Gastric ulcers, often associated with factors such as stress, infection, and non-steroidal anti-inflammatory drugs [NSAIDs], involve the erosion of the stomach's protective mucosal lining. *E hirta*'s purported anti-ulcer activity may be linked to its ability to modulate various physiological processes, including its anti-inflammatory and antioxidant properties. These attributes could potentially help in preventing or alleviating the damage caused by ulcerogenic factors. Understanding the anti-ulcer activity of *E hirta* holds promise not only for addressing gastric ulcers but also for providing insights into its broader gastroprotective potential.

The anti-ulcer effects of the ethanolic extract of the aerial parts of *E. hirta* were assessed in rats by Rathna Kumar *et al*. 2013. The oral administration of 200 and 400mg/kg of *E. hirta* significantly inhibited the formation of ulcers in rats induced by pylorus ligation, indomethacin, HCl/EtOH, and restraint stress. In rats with pylorus ligation, the pretreatment with *E. hirta* extract reduced gastric output. In rats with ulcers caused by HCl/EtOH, the pretreatment of *E. hirta* at 200 and 400mg/kg greatly conserved the mucus on the stomach wall. Results indicated that the ethanolic extract of *E. hirta* has a protective gastroprotective effect, partly due to its anti-secretory qualities and ability to preserve gastric mucus production [37].

Das Prabhat *et al.* 2009 carried out gastroprotective effects of an aqueous extract of *E hirta* whole plant in Wistar rats. A duodenal ulceration model was used for the study. They used 450mg/kg of cysteamine hydrochloride to cause the duodenal ulcers. The standard drug used was ranitidine 20mg/kg. Next, the plant's ethanolic 250mg/kg and aqueous 300mg/kg extracts are employed as test drugs and contrasted with the powerful duodenal ulcer-causing agent cysteamine hydrochloride. Cysteamine-induced duodenal ulceration was significantly healed by both of the plant *E hirta* extracts. Compared to the ethanolic extract, the aqueous extract of *Euphorbia hirta* exhibited more potent activity [38].

Kori Yashpal *et al*. 2020 identified a critical flavonoid called Rutin and synthesized a novel Rutin derivative from an ethanolic extract of the whole *E hirta* Linn plant and investigated its anti-hemorrhoid activity. To compute the anti-hemorrhoid potential, the recto anal coefficient was employed. The rectoanal cell line showed exceptional recovery after five days of therapy with isolated rutin and semi-synthesized drug, as compared to ethanolic extract. Therefore, promising anti-haemorrhoidal activity was demonstrated by isolated and semi-synthetic rutin from ethanolic extract [39].

Table 2 Extraction, Pharmacological activity, and Results of *Euphorbia hirta*

Plant part	Extraction Method	Pharmacological Activity	Result	Reference
Whole plant	Soxhlet (Ethanol)	Anti-hyperglycaemic	The anti-hyperglycaemic activity was significant. (P<0.001)	[40]
Leaves	Maceration (Distilled water)	Anti-oxidant	The anti-oxidant activity was significant.	[41]

Whole plant	Maceration (Hexane, MeOH)	Anti-inflammatory	The anti-inflammatory activity was significant. (P<0.005)	[42]
Stem	Soxhlet (Petroleum ether, Ethanol)	Anti-hyperlipidaemic, anti-hyperglycaemic and anti-oxidant.	The anti-hyperlipidaemic, anti-hyperglycaemic, and anti-oxidant activity was significant. (P<0.001)	[43]
Leaves	Soxhlet (Ethanol)	Anti-inflammatory, anxiolytic.	The anti-inflammatory and anxiolytic activity was significant. (P<0.05)	[28]
Leaves	Maceration (Methanol)	Anti-thrombotic, anti-inflammatory.	The anti-thrombotic and anti-inflammatory activity was significant. (P<0.05)	[29]
Leaves	Maceration (Dwastilled water, Ethanol)	Antioxidant, anti-fungal	The anti-oxidant and anti-fungal activity were significant. (P<0.05)	[22]
Leaves	Maceration (Methanol, Ethyl acetate, n-hexane)	Anti-mycobacterial.	The anti-mycobacterial activity was significant	[45]
Whole plant	Cold percolation (Methanol)	Anti-lewashmanial, antioxidant, anti-bacterial	The anti-lewashmanial, antioxidant, and anti-bacterial activity was significant. (P<0.05)	[46]
Leaves and stem	Maceration (Sterile water, Ethanol)	Anti-bacterial	The anti-bacterial activity was significant	[47]
Leaves	Soxhlet (Petroleum ether, benzene, chloroform, ethanol, and water)	Sedative and hypnotic	The sedative and hypnotic activity was significant. (P<0.01)	[48]
Leaves and stem	Maceration (Dwastilled water)	Anti-gout	The anti-gout activity was significant. (P<0.05)	[49]
Whole plant	Soxhlet (Ethanol)	Anti-hemorrhoidal	The anti-hemorrhoidal activity was significant. (P≤0.05)	[39]
Whole plant	Soxhlet (Dwastilled water)	Anti-cancer	The anti-cancer activity was significant (P<0.05).	[33]
Leaves	Maceration (Ethanol)	Cardioprotective	The cardioprotective activity was significant (P<0.05).	[50]
Leaves	Maceration (Methanol)	Anti-psoriatic	The anti-psoriatic activity was significant (P<0.05).	[51]
Whole plant	Soxhlet (Methanol)	Anti-malarial	The anti-malarial activity was significant (P<0.05).	[52]
Whole plant	Maceration (Absolute methanol, Petroleum ether, Chloroform, Ethyl acetate, Butanol)	Anti-bacterial, antioxidant, and anti-cancer.	The anti-bacterial, antioxidant, and anti-cancer activity was significant. (P<0.01), (P<0.05), (P<0.001),	[20]

Whole plant	Soxhlet (Crude n-hexane, Chloroform, Ethanol, Water)	Anti-proliferative, antioxidant, bronchodilatory.	The antioxidant, antiproliferative, and bronchodilatory activity was significant.	[53]

5. Role of *E. hirta* in Various Medicinal Aspects

E. hirta, also known as "Asthma Plant" or "Garden Spurge," has been used in traditional systems of medicine such as Ayurveda, Siddha, Unani, and others. However, it's important to note that scientific evidence supporting its efficacy is limited, and its use should be approached with caution. In Ayurveda, *E. hirta* is traditionally used for respiratory conditions, as an expectorant, and for digestive issues. It may be used in herbal formulations for respiratory health, but specific formulations can vary widely. In Siddha medicine, *E. hirta* is believed to have anti-inflammatory properties and may be used for respiratory issues. Siddha formulations can include *E. hirta* for various conditions, but detailed information on specific formulations would require referencing Siddha texts. In Unani medicine, it may be used for respiratory disorders, gastrointestinal issues, and as a diuretic [55]. *E. hirta* might be included in various Unani formulations, but details would be found in specific Unani texts. Homeopathy might use *E. hirta* for certain symptoms, but the approach in homeopathy is highly individualized, and remedies are chosen based on the overall symptom picture. *E. hirta* may be prepared as a homeopathic remedy, but specific formulations would depend on the homeopathic pharmacopeia. In Traditional Chinese Medicine TCM, *E. hirta* might be used for conditions such as respiratory issues, skin conditions, and infections. TCM formulations can vary widely, and *E. hirta* might be part of specific herbal combinations. In Thai traditional medicine, it might be used for respiratory conditions, digestive issues, and as an anti-inflammatory. Specific formulations in Thai traditional medicine would require referencing traditional Thai medical texts [54].

It's important to emphasize that the information provided here is based on historical and traditional uses, and scientific evidence supporting these uses is limited. Always consult with qualified practitioners in each system of medicine before using *E. hirta* or any other herbal remedy. Additionally, traditional medicine practices and formulations can vary, and local regulations should be considered

6. Conclusion

Euphorbia. hirta reveals a rich diversity of phytochemical constituents, contributing to its traditional uses and potential pharmacological activities. This plant has been traditionally employed in various medicinal systems, including Ayurveda, Siddha, Unani, and others, for conditions such as respiratory disorders, gastrointestinal issues, and anti-inflammatory purposes. Phytochemical analyses highlight the presence of compounds like flavonoids, alkaloids, and terpenoids, suggesting potential therapeutic properties. Pharmacological studies indicate anti-inflammatory, antioxidant, anti-cancer, anti-ulcer, and anti-asthmatic activities, among others. However, it's crucial to note the limited scientific evidence and further rigorous research is needed to validate these claims and explore the safety and efficacy of *Euphorbia hirta*. Future studies should focus on conducting well-designed clinical trials to establish its clinical effectiveness, elucidate the mechanisms of action, and determine optimal dosage regimens. Additionally, comprehensive toxicity studies are essential to ensure the safety of *Euphorbia hirta* in various populations. Integrating traditional knowledge with modern scientific methodologies can provide valuable insights for the development of evidence-based therapeutic interventions.

Compliance with ethical standards

Disclosure of conflict of interest

There was no conflict of interest among the authors.

References

[1] Ramawat KG, Goyal S. The Indian herbal drugs scenario in global perspectives. Bioactive molecules and medicinal plants. 2008 Oct 16:325-47.

[2] Pandey MM, Rastogi S, Rawat AK. Indian traditional ayurvedic system of medicine and nutritional supplementation. Evidence-Based Complementary and Alternative Medicine. 2013 Jun; 2013.

[3] Hegde BM. Future medicare system. Journal-Association of Physicians of India. 2003 Jun 1; 51:606-8.

[4] Sen S, Chakraborty R. Revival, modernization and integration of Indian traditional herbal medicine in clinical practice: Importance, challenges and future. Journal of traditional and complementary medicine. 2017 Apr 1; 7(2):234-44.

[5] Ernst M, Grace OM, Saslis-Lagoudakis CH, Nilsson N, Simonsen HT, Rønsted N. Global medicinal uses of Euphorbia L. (Euphorbiaceae). Journal of ethnopharmacology. 2015 Dec 24; 176:90-101.

[6] Singh G, Kumar P. Phytochemical study and screening for antimicrobial activity of flavonoids of Euphorbia hirta. International Journal of Applied and Basic Medical Research. 2013 Jul; 3(2):111.

[7] Huang L, Chen S, Yang M. Euphorbia hirta (Feiyangcao): A review on its ethnopharmacology, phytochemistry and pharmacology. Journal of Medicinal Plants Research. 2012 Oct 10;6(39):5176-85

[8] Ramesh KV, Padmavathi K. Assessment of immunomodulatory activity of Euphorbia hirta L. Indian journal of pharmaceutical sciences. 2010 Sep; 72(5):621.

[9] Gopi K, Renu K, Vishwanath BS, Jayaraman G. Protective effect of Euphorbia hirta and its components against snake venom induced lethality. Journal of ethnopharmacology. 2015 May 13; 165:180-90.

[10] Ghosh P, Ghosh C, Das S, Das C, Mandal S, Chatterjee S. Botanical description, phytochemical constituents and pharmacological properties of Euphorbia hirta Linn: a review. International Journal of Health Sciences and Research. 2019; 9(3):273-86.

[11] Rajeh MA, Zuraini Z, Sasidharan S, Latha LY, Amutha S. Assessment of Euphorbia hirta L. leaf, flower, stem and root extracts for their antibacterial and antifungal activity and brine shrimp lethality. Molecules. 2010 Aug 31; 15(9):6008-18.

[12] Dhanapal V, Kumar S. Pharmocognostical and phytochemical evaluation of leaf and stem of Euphorbia hirta. Journal of Pharmacognosy and Phytochemistry. 2017; 6(6):255-62.

[13] Das K, Asdaq SM, Khan MS, Amrutha S, Alamri A, Alhomrani M, Alsanie WF, Bhaskar A, Harshitha P. Phytochemical investigation and evaluation of in vitro anti-inflammatory activity of Euphorbia hirta ethanol leaf and root extracts: A comparative study. Journal of King Saud University-Science. 2022 Oct 1; 34(7):102261.

[14] Karki S, Shrestha K, Gautam R, Jha RN. Phytochemical screening, FT-IR and GC-MS analysis of Euphorbia hirta. Journal of Pharmacognosy and Phytochemistry. 2020; 9(1):1883-9.

[15] Dhanapal V, Kumar S. Pharmocognostical and phytochemical evaluation of leaf and stem of Euphorbia hirta. Journal of Pharmacognosy and Phytochemistry. 2017; 6(6):255-62.

[16] Basyal D, Neupane A, Pandey DP, Pandeya S. Phytochemical Screening and In Vitro Antioxidant and Anti-inflammatory Activities of Aerial Parts of Euphorbia hirta L. Journal of Nepal Chemical Society. 2021 Mar 2; 42(1):115-24.

[17] Bhat SA, Mir SA, Maqbool M, Bhat AU, Masoodi MH. Evaluation of phytochemical, antioxidant, and in-vitro antidiarrheal, activity of Euphorbia hirta. Journal of Drug Delivery and Therapeutics. 2019 Feb 15;9(1-s):290-4.

[18] Sharma N, Samarakoon KW, Gyawali R, Park YH, Lee SJ, Oh SJ, Lee TH, Jeong DK. Evaluation of the antioxidant, anti-inflammatory, and anticancer activities of Euphorbia hirta ethanolic extract. Molecules. 2014 Sep 15; 19(9):14567-81.

[19] Ismail A, Mohamed M, Kwei YF, Yin KB. Euphorbia hirta methanolic extract displays potential antioxidant activity for the development of local natural products. Pharmacognosy Research. 2019; 11(1).

[20] Tran N, Nguyen M, Le KP, Nguyen N, Tran Q, Le L. Screening of antibacterial activity, antioxidant activity, and anticancer activity of Euphorbia hirta linn. Extracts. Applied Sciences. 2020 Nov 26; 10(23):8408.

[21] Asha S, Thirunavukkarasu P, Mani VM, Sadiq AM. Antioxidant activity of Euphorbia hirta Linn leaves extracts. European Journal of Medicinal Plants. 2016 Jan 10; 14(1):1-4.

[22] Mekam PN, Martini S, Nguefack J, Tagliazucchi D, Stefani E. Phenolic compounds profile of water and ethanol extracts of Euphorbia hirta L. leaves showing antioxidant and antifungal properties. South African Journal of Botany. 2019 Dec 1; 127:319-32.

[23] Jakhar S, Dahiya P. Antibacterial, antioxidant activity and phytochemical analysis of Euphorbia hirta Linn. Microbiol Res J Int. 2017; 20:1-2.

[24] Olaoluwa O, Moronkola D, Taiwo O, Iganboh P. Volatile oil composition, antioxidant and antimicrobial properties of Boerhavia erecta L. and Euphorbia hirta L. Trends in Phytochemical Research. 2018 Sep 1; 2(3):171-8.

[25] Kain D, Kumar S, Suryavanshi A, Arya A. FTIR and GCMS analysis of Euphorbia hirta L. and its In-vitro Antibacterial and Antioxidant Activities. Indo Global Journal of Pharmaceutical Sciences. 2022 Jan 31; 12:104-9.

[26] Basyal D, Neupane A, Pandey DP, Pandeya S. Phytochemical Screening and In Vitro Antioxidant and Anti-inflammatory Activities of Aerial Parts of Euphorbia hirta L. Journal of Nepal Chemical Society. 2021 Mar 2; 42(1):115-24.

[27] Chen J, Er H, Mohamed S, Chen Y. In vitro anti-inflammatory activity of fractionated Euphorbia hirta aqueous extract on rabbit synovial fibroblasts. Biomedical journal. 2015 Jul 1; 38(4).

[28] Xia M, Liu L, Qiu R, Li M, Huang W, Ren G, Zhang J. Anti-inflammatory and anxiolytic activities of Euphorbia hirta extract in neonatal asthmatic rats. AMB Express. 2018 Dec; 8(1):1-1.

[29] Rahman MS, Rana S, Islam AA. Antithrombotic and anti-inflammatory activities of leaf methanolic extract of Euphorbia hirta Lin. Int J Complement Alt Med. 2019; 12(4):154-62.

[30] Upadhyay A, Chattopadhyay P, Goyary D, Mazumder PM, Veer V. Anti-inflammatory effect of Euphorbia hirta leaf extract in rats and modulation of inflammation-associated prostaglandins (PGE-2) and Nitric Oxide (NO) expression in RAW264. 7 macrophage. Journal of Pharmaceutical Sciences and Pharmacology. 2014 Mar 1; 1(1):68-73.

[31] Shih MF, Cheng YD, Shen CR, Cherng JY. A molecular pharmacology study into the anti-inflammatory actions of Euphorbia hirta L. on the LPS-induced RAW 264.7 cells through selective iNOS protein inhibition. Journal of natural medicines. 2010 Jul; 64:330-5.

[32] Anitha P, Geegi PG, Yogeswari J, Anthoni SA. In Vitro Anticancer activity of Ethanolic extract of Euphorbia hirta (L.). Science, Technology and Arts Research Journal. 2014 Jun 4; 3(1):01-7.

[33] Sulaiman CT, Deepak M, Praveen TK, Lijini KR, Salman M, Sadheeshnakumari S, Balachandran I. Metabolite profiling and anti-cancer activity of two medicinally important Euphorbia species. Medicine in Omics. 2023 Mar 1; 7:100018.

[34] Vijayapriya M, Mahalakshmi S, Christiya CR. In-Vitrostudies on Antiproliferative Effect of Euphorbiahirta L Leaves. Annals of the Romanian Society for Cell Biology. 2021 Apr 26:11111-26.

[35] Rajakumaran S, Christiya RC. Anti-proliferative effects of Euphorbia hirta L on the activity of cytotoxicity in bone cancer MG-63 cells. Research Journal of Pharmacy and Technology. 2021; 14(4):2221-3.

[36] Mali PY, Sable RR, Naphade VD, Pathan VT, Gujarathi NA, Jadhav AG. Evaluation of cytotoxicity of methanolic extract of Euphorbia hirta against NCIH-522 and vero cell line. Inventi Impact: Animal Models and Cell Assays. 2017; 1(1):1-5.

[37] Rathnakumar K, Jaikumar S, Sengottuvelu S. Antiulcer activity of Euphorbia hirta against experimentally induced ulcer in rats. Asian Journal of Pharmaceutical Research. 2013; 3(3):121-4.

[38] Das PK, Sahoo S, Sethi R, Nayak PS, Nayak S. Pharmacological Investigation of Protective Effects of Euphorbia hirta Whole Plant Extract, Against Duodenal Ulceration in Wistar Rats. Research Journal of Pharmacology and Pharmacodynamics. 2009; 1(3):150-3.

[39] Kori YS, Yogi B, Gupta S. Antihaemorrhoid activity of Isolated and semi-synthesized Rutin Derivative from Euphorbia hirta Linn. Research Journal of Pharmacy and Technology. 2020; 13(3):1333-8.

[40] Kumar S, Kumar D. Evaluation of antidiabetic activity of Euphorbia hirta Linn. in streptozotocin induced diabetic mice

[41] Sharma NK, Dey S, Prasad R. In vitro antioxidant potential evaluation of Euphorbia hirta L. Pharmacologyonline. 2007 Jan 1; 1:91-8.

[42] Vazquez MM, Apan TO, Lazcano ME, Bye R. Anti-inflammatory active compounds from the n-hexane extract of Euphorbia hirta. Journal of the Mexican Chemical Society. 1999; 43(3-4):103-5.

[43] Sunil K, Rashmi M, Dinesh K. Antihyperglycemic, antihyperlipidemic and antioxidant activities of Euphorbia hirta stem extract. Int. Res. J. Pharm. 2010; 1(1):150-6.

[44] Rajasekar T, Anbarasu S, Manikkam R, Joseph J, Kumar V. Inhibitory activity of Euphorbia hirta (Tawa-tawa) extracts against Mycobacterium tuberculosis and other non-mycobacterial pathogens. Der Pharma Chemica. 2015; 7(8):213-6.

[45] Gupta RE, Gupta JI. Investigation of antimicrobial activity of euphorbia hirta leaves. International Journal of Life science and Pharma Research. 2019 Jul;9(3):32-7.

[46] Sharma KR. Phytotoxic, Antioxidant, Antibacterial, And Antileishmanial Activities Of *Euphorbia hirta* From Chitwan District Nepal. Asian J Pharm Clin Res. 2020; 13(2):146-9.

[47] Edrees WH. The inhibitory effect of *Euphorbia hirta* extracts against some wound bacteria isolated from Yemeni patients. Chronicles of Pharmaceutical Science. 2019; 3:780-6.

[48] Venkatachalam D, Samuel Thavamani B, Kumar S. Sedative activity of ethanolic and aqueous extracts of *Euphorbia hirta*. seeds. 2018; 9:12.

[49] Abu Bakar FI, Abu Bakar MF, Abdullah N, Endrini S, Fatmawati S. Optimization of extraction conditions of phytochemical compounds and anti-gout activity of *Euphorbia hirta* L.(Ara Tanah) using response surface methodology and liquid chromatography-mass spectrometry (LC-MS) Analysis. Evidence-Based Complementary and Alternative Medicine. 2020 Oct;2020

[50] Anandhi DV, Sowndarya R. Cardioprotective activity of *Euphorbia hirta* in isoproterenol induced myocardial infarction in rats. J Med Plants Stud. 2017;5(3):335-7.

[51] Jaikumar S. Screening of *Euphorbia hirta* Leaves for Antipsoriatic Activity in Mice.

[52] Iyekowa O. DETERMINATION OF ANTIMALARIAL ACTIVITY OF METHANOL EXTRACT OF *Euphorbia hirta* USED LOCALLY AS HERBAL TEA AMONG RURAL DWELLERS IN OVIA NORTH-EAST LGA, EDO STATE, NIGERIA.

[53] Chen YS, Er HM. Antioxidant, anti-proliferative and bronchodilatory activities of *Euphorbia hirta* extracts. Malaysian Journal of Science. 2010 Apr 29;29(1):22-9.

[54] Arunachalam LT. Siddha Medicine. Chennai: International Institute of Tamil Medicine; 2010. p. 45-58.

[55] Sharma PV. Dravyaguna Vijnana. Varanasi: haukhamba Bharati Academy; 2005. p. 12-125