Innovation of Chemistry & Materials for Sustainability
Volume 3, Issue 1, Jan.-June **2026**
REVIEW ARTICLE
ISSN (Print): 3049 – 2548
ISSN (Online): 3049 – 0146

Euphorbia royleana Boiss: A Systematic Review on Traditional Uses, Phytochemistry, Pharmacological Properties and Toxicological Activities

Pallavi Kumari[a], Rishabh Kaundal[b], and Yogesh Kumar Walia[a]*

[a]Department of Chemistry, School of Basic & Applied Sciences, Career Point University, Hamirpur-176041, Himachal Pradesh, India
[b]Chemical Technology Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061, Himachal Pradesh, India

*Correspondence: yogesh.che@cpuh.in (Y. K. Walia)

Abstract: *Euphorbia royleana* (family: Euphorbiaceae) is a cactus plant bearing milky latex with traditional medicinal uses to treat various diseases and conditions like gastro-intestinal problems, laceration, wounds, earache, skin problems, arthritis etc. This review documents the ethnomedical uses, phytochemistry, pharmacological activities and toxicological studies of *E. royleana* to identify the remaining gaps and supply a basis for further investigations. The data and information on *E. royleana* was retrieved using various databases such as PubMed, Springer, Taylor and Francis imprints, ScienceDirect, Google Scholar, ChemSpider, SciFinder, research and review articles from peer-reviewed journals and unpublished data such as PhD thesis, in addition to ethnobotanical books, chapters and Wikipedia. Phytochemical investigations have led to the isolated structurally diverse diterpenoids and triterpenoids with reported pharmacological activities as Anti angiogenic, Inhibiting NO production in BV-2 cells, MDR modulator, *in-vitro* cytotoxicity. *E. royleana* is a valuable medicinal source and further studies in this topic can validate the traditional and ethnobotanical use of the plant. Furthermore, there are gaps need to filled before therapeutic uses validation because the long-term in vivo toxicity and clinical efficacy of *E. royleana* formulations have not been thoroughly demonstrated. The present review thus highlights *E. royleana* as a pharmacologically valuable yet underexplored medicinal plant and it strongly supports for systematic phytochemical, and clinical investigations.

Keywords: *Euphorbia royleana, traditional, ethnobotanical, pharmacology, toxicology*

Abbreviations: WHO- World Health Organization; DPPH- 2,2-diphenylpicrylhyrazyl; ABTS- 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid); NO scavenging - Nitric oxide scavenging; Caco-2 - human colon adino-carcinoma cells; BV-2 cells- microglial cell; MDR- Multi Drug Resistance; IC_{50} – half maximal inhibitory concentration; HL-60–human myeloid leukemia cell; $HepG_2$- Human hepatoma liver cell; BALB/3T3- embryonic cell line, normal murine fibroblast; CMT1- canine mammary gland tumors; MPG- canine mammary gland tumors; NWHR- north western Himalayan range; *S. pneumonia - Streptococcus pneumonia; F. Solnai- Fusarium Solnai; A. niger - Aspergillus niger; F. oxysporum - Fusarium oxysporum; S. typhi- Salmonella typhi; K. pneumonia- Klebsiella pneumonia; P. vulgaris- Proteus vulgaris; P. multocida - Pasteurella multocida; B. subtilis - Bacillus subtilis; E. coli - Escherichia coli; P. chrysogenum - Penicillium chrysogenum*

Contents

1. Introduction

From the earliest archaeological evidence to the advent of industrial agro-ecosystems, humans have remained contingent upon the plant diversity. The knowledge of folk medical practices has been transferred from our ancestors to us.[1] In rural areas, 80% of the population worldwide depends on herbal medicine for their healthcare needs.[2] WHO explains the traditional medicine system as the sum total of the knowledge, skills, beliefs, and practices based on theories, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment or physical and mental illness.[3] Therefore, the increasing dependence on the use of medicinal plants in industrialized cultures is yielding to the advancement of extraction and also in improvement of medicines and clinical treatments. The presence of natural compounds in different parts of plant are less harmful and has no adverse effects resulting in making medicinal plants more popular and making them useful in the treatment of disease. This is evident from the fact that natural products are playing an important role in the treatment of cancer and infectious diseases.[4,5]

The family Euphorbiaceae has a wide range of diversity and comprise large woody trees to simple weeds.[6] Euphorbiaceae is one of the biggest families of flowering plants, composed of over 300 genera and 8000 species.[7,8,9] One of the largest genus in the family Euphorbiaceae is *Euphorbia* which comprises over 2000 species and includes small trees, shrubs, herbaceous plants, vines, and sacculents.[10,11] The genus can be found in all temperate and

https://doi.org/10.63654/icms.2026.03086 *Innov. Chem. Mater. Sustain.* **2026**, *3*(1), 86-97
Received: 03 May 2026; Revised: 22 June 2026; Accepted: 23 June 2026; Published (online): 29 June 2026

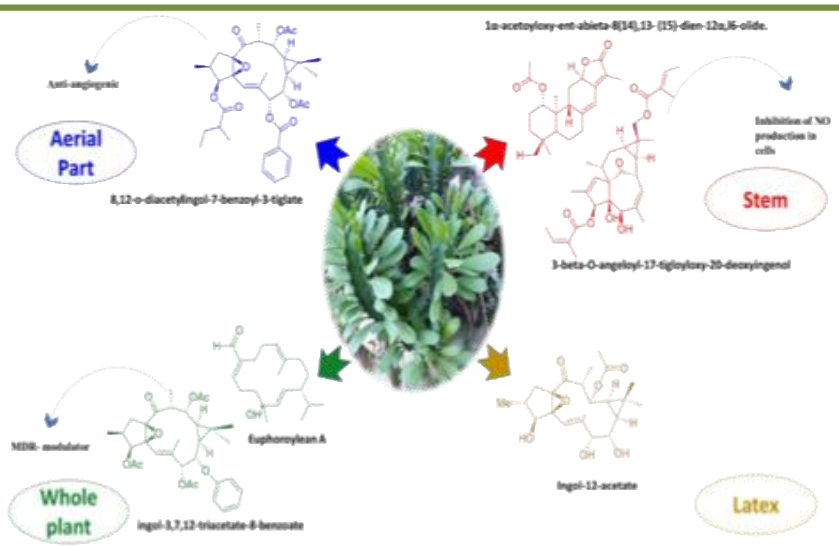

Figure 1. *Isolated potent bio-molecules from different plant parts of E. royleana Boiss*

tropical regions and has a worldwide distribution.[11] This wide distribution of the genus might be the reason of the presence of bioactive secondary metabolites of different classes.[12,13] The genus *Euphorbia* is known as spurges and is commonly used as an ornamental plant.[14] Spurges usually exudates white latex on cutting.[15,16] Genus is scientifically reported for its anticancer, cytotoxic, antimicrobial and antiviral activities.[17,18] Several plants of genus *Euphorbia* are known as folk herbal medicine mainly in 'Traditional Chinese Medicine'.[16] Plant parts of species of this genus are widely used for the treatment of liver diseases, snake bites, cancer, ascites, rheumatism, joint and leg pain.[7,19] *E. royleana* species of *Euphorbia* genus are mostly found in eastern and western ghats of Himalayas in dry rocky hilly areas and species native to China South-Central, China Southeast, East and West Himalayas of India, Myanmar, Nepal, Pakistan. *E. royleana* is known as chuu (chuuein), sullu in northern India.[20,21] More than 190 species of genus *Euphorbia* are reported in India.[22] The plant is used traditionally for the treatment of ailments like paralysis, loose motions, bladder stones, and ear pain.[23] Piscicidal and anti-acetylcholinesterase activity were shown by the Stem bark extract of *E. royleana.*[24] Anti-inflammatory and anti-arthritic activities were shown by the latex of the plant.[25] Also, nanoparticles of *E. royleana* whole plant and leaves extract possess biological activities and have great potential for both sustainable environmental and nanomedicine, especially in combating microbial infections and illnesses associated with oxidative stress related disorders.[26, 27]

The study on chemical constituents of *E. royleana* along with its pharmacological activities has been made. Diterpenoids, and triterpenoids were isolated and identified as potent molecules along with their cytotoxic nature. In the current paper, an overview of the current knowledge and information about *E. royleana* is presented for the study of its ethnopharmacology, phytochemistry, pharmacology, and toxicology.

2. Materials and Method

Presently collective information on E. royleana plant since 1862-2023 has been set. The review explains about the summary of up-to-date information on botany, phytochemistry, ethnomedicinal uses and biological activities. To explore the ethnomedical uses, phytochemistry and pharmacology of the E. royleana species, an extensive literature search has been made. Many of the search terms used includes: *E. royleana* and taxonomy, ethnomedical uses, phytochemistry and pharmacology of E. royleana species. The terms were studied and systematically summarized and organized into many titles to facilitate the understanding. This review was conducted mainly by using different scientific databases such as PubMed, Google Scholar, Scopus and Science Direct.

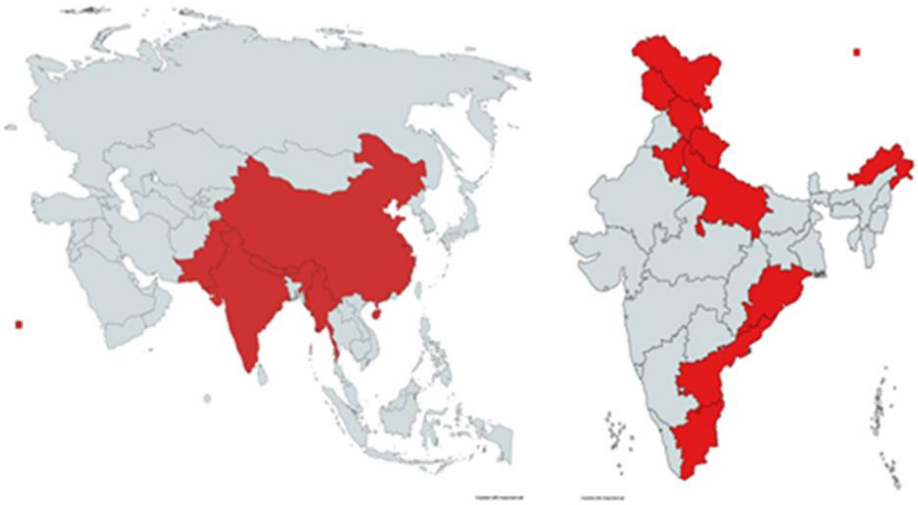

Figure 2. *Distribution of Euphorbia royleana in Asia and in India (Source: MAP CHART: https://www.mapchart.net/)*

Also, ChemDraw 16.0 software has been used for the drawing of chemical structures. The results of this review research were interpreted, analyzed and documented based on the bibliographical information obtained. Ancient texts were also consulted and local information available in sources such as PhD and MSc theses, books. The review is divided into four main parts: ethnopharmacology, phytochemistry, bioactivities of extracts and toxicity.

2.1. Ethnopharmacology

Distribution: In India, there are total 195 species of genus *Euphorbia.*[21] Habitat of plant *E. royleana* is dry rocky hill slopes. Communities of the species are mostly found in eastern and western ghats of Himalayas.[25,28] Species is native to India, China, Pakistan, Myanmar, Nepal.[29]

Plant profile: The scientific classification of the plant *E. royleana* is:

Kingdom - Plantae
Division - Tracheophyte
Class – Spermatophyta
Order – Magnoliopsida
Family – Euphorbiaceous
Genus – *Euphorbia*
Species – *royleana*

Plant *E. royleana* gives an appearance like cactus, and is a thorny succulent shrub, 5-7 meters tall, glabrous.[30,31,32,33] Leaves are green and fleshy and are arranged alternatively, and they get shredded off in the hot and summer season.[34] Stems are thick and sponges, 5-7 angled and prickles are attached to it and are paired. Cyathia in sessile 'cymes' of 3 each, arising from the internodal sinuses, yellowish in colour[32] And, the synonyms of species are *Euphorbia pentagona Haw* & *Euphorbia pentagona Royle.*[36,37]

Some common names of the *E. royleana* species are as follows:

English: Sullu spurge,
Hindi: Chhun, dandathor, senhur, shakarpitan,
Nepali: Siundee,
Sanskrit: Nanda, Nisrinsapatra, Saptala,
Urdu: Thuhar[20]

Ethnomedicinal Information: *E. royleana* parts *are* widely used in India and some other countries to treat various human diseases and have curative properties. In most cases, the species is used to treat gastro-intestinal problems and to cure lacerations. In some parts of the world, plant is considered as ornamental plant and used as fencing for keeping stray animals away. The latex part is commonly used for various ailments in ethno-culture. Other parts used are roots, stem, leaves, and pith. Table 1 & 2 represents the data about ethnomedicinal knowledge with their treatments available and the local names of the plant around the world and in India.

In Nepal, latex is used to treat stomachic disorder and the mixture of it with honey is used as an anti-helminitic medicine to treat muscular swellings. Juice of leaves is used to treat bronchitis and pneumonia.[41,44] Roots have been used for the treatment of cough.[45] In Pakistan, burning stem is used for relaxing an earache and the jelly like material obtained by removal of bark is useful in removal of urinary bladder stones.[23]

Various states of India use the E. royleana plant for their needs provided by their ancestral knowledge and plant parts are used accordingly for the diseases and the ailments to cure. Latex of the plant is used for the treatment of male impotency as it is known as goumutra shilajit, in Ayurveda.[20] It is also used on animals by topical method for curing fracture bones, for stimulating ovulation, to treat cataract of cattle and for the treatment of tail infection in animals.[5,9,52,59,60] Milky latex is used externally for ring worm, rheumatism, boils, warts, etc.[61] The latex is applied as gulon on the painful parts, but care should be taken that water should not touch on that part and latex must be kept away from the eyes. Latex is filled in the hollow cavities of decayed tooth.[56] Small pieces of stem are fried in mustard oil till amount of oil reduced to 1 by 10th of the original.[21] Juice of heated leaves is applied to earache and paste of crushed leaves is used to cure wounds and skin eruptions.[57] In case of snake bite, decoction prepared from small roots and kali mirch is given to patient as a medicine. Stimulating ovulation and tail infection in animals is also treated.[53] The pith of unripe papaya fruit is cooked with chicken to keep it hydrated and used to prevent liver disease and chronic fever.[61] Mixtures of stem with other plant parts used for the treatment of cold and anaemia in the form of paste and powder respectively.[51]

2.2. Bioactivities of Extracts

Extracts of different plant parts of *E. royleana* species were investigated for bioactivity by different methods. *In-vitro and in-vivo* studies showed anti-tumor, antioxidant, anti-fungal, anti-inflammatory, anti-diabetic, cytotoxic activity. Among all the

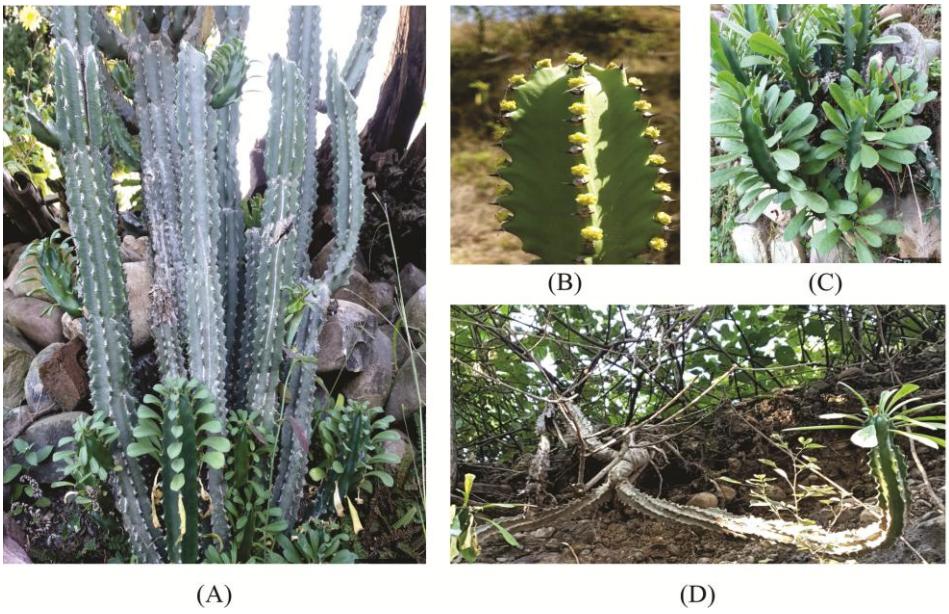

Figure 3. *(A) Whole plant of E. Royleana Boiss. growing on dry hill rocks showing habitat (B) Yellow flowers of species blossoming in the month of February-March (C) Leaves of E. Royleana (D) E. royleana species on dry hill slopes.*

Table 1. Ethnomedicinal uses around the world.

S. No	Place	Local name	Part use	Uses	Treatment	References
				China		
1.	Guangdong	Hainan: Guangxi:	WP	Acuteskin diseases, psoriasis	-	38
				Nepal		
2.	Western Nepal	Siundi	S, L	Flatulence & dermatological problems.	Burning stem for gastritis& latex for dermatological disorder.	39
	Pyuthan district	Siyuri	S, F	Gastric troubles, cuts and wounds	Juice and paste of leaves is for fever and cuts.	40
	Myagdi District	Siyuri	L, F, P	Anti-helminiticto treat muscular swellings.	Latex with honey as an anthelminitic medicine and muscular swellings. pith for stomachache and juice of the leaf as a peadiatric medicine.	41
	Myagdi District	Siundee	WP	Anthelmintic, appetizer, gastro-intestinal problems, cathartic, fever.	-	42
	Watershed area	Siudi	L	To treat joint and leg pain	-	19, 43
	Rupandehi	Sihundisinghe	L, F	Bronchitis, pneumonia, stomachic disorders	Latex is used for gastric diseases. Warm leaf juice is used to treat bronchitis and pneumonia.	44
	Terai plains	Siundi	WP, R	Timber for fences.	Root for the treatment of coughs	45
	Kaski (Pokhara metropolis)	Siundi	F, S	Gastro-intestinal disorder, fractures, oral and tooth ailments.	-	46
	Ilam district		L, S	Anorexia, stomach disorder, Conjuctivities	Latex is applied carefully on temper of opposite side of infected eye	47
				Pakistan		
3.	Lahore	Danda thor	S, R	Hepattitis	-	48
	Islamabad	Danda thor	WP	Catharatic, anthelminitic	-	49
	Abbotabad City	Dozkhimeva/ zakoom/ cactus	S	Earache, paralysis, loose motions, bladder stones.	Burning stem for earache and by removing the bark of plant and eating the jelly like material is useful removal of urinary bladder stones.	23
	Malakand	Zahro botay	L	Analgesic &anti-inflammatory	-	50

Abbreviations: WP-whole plant; L- latex; S-stem; F-leaf; R-root; B-bark

different plant parts, latex extract with different solvents is commonly investigated for the cytotoxic activity, anti-inflammatory, anti-diabetic activity and showed appreciable results. Table 3 describes the biological activities of organic extracts of plant parts.

Anti-inflammatory activity: *in-vivo* anti-inflammatory activity performed on rats and mice of ethyl acetate fraction from 85% ethanol and of hydro-soluble fraction. The higher dose tested (200 mg/kg) showed 35.93% inhibition in rats and 33.28% in mice by Carrageenan-induced oedema test in rats and mice of ethyl acetate latex extract. It also showed marked inhibitory activity against histamine, 5- hydroxytryptamine and dextran-induced oedema in rats. Also, results explain that ethyl acetate shows an anti-inflammatory effect in rats with adrenalectomies, but it does not appear to function by activating the adrenal pituitary axis.[68] Both acute and chronic models of inflammation is tested in rats by hydro soluble fraction of latex and was active in suppressing the paw oedema. Leukocyte migration produced less volume of exudate because of the latex's strong dose-dependent anti-inflammatory activity. It also had a mild inhibitory effect on the development of granulomas brought on by cotton pellets. It showed better gastrointestinal tolerance in rats compared to standard drug, acetylsalicylic acid used.[25]

Anti-oxidant activity: Free radicals are thought to be the cause of several ailments and the use of synthetic antioxidants are restricted, due to their carcinogenic effects. As a result, scientists have concentrated on natural antioxidants. Whole plant, latex and stem checked for their antioxidant activity. Free radical scavenging activity and DPPH assay of whole plant represents good result of hexane extract (0.38 mg/mL) among methanol and aqueous extract. Also, all the 3 investigated extracts reducing capacity increases with increase in concentration (25-800 µg/mL).[71] Anti-oxidant activity of lyophilized latex analysed by DPPH neutralisation (96.3 µg/mL), NO scavenging ability (1.87 mg/mL). Reduction potential was also examined using FRAP assay and comes out to be 15.8 mg vitamin C equivalents per gram of dry weight. Free radical scavenging ability and high reduction potential makes the *E. royleana* lyophilized latex a good source of antioxidant agents.[73] Among the methanol and DCM extract by maceration process of stem, methanol extract (70.1 mg/mL) shows good DPPH scavenging activity.[75]

Anti-microbial activity: The three extracts of fresh plant with the solvent methanol, hexane, and aqueous extracts investigated for antimicrobial activity against six pathogenic microorganisms. Hexane and methanolic extracts shows good results against *A. Niger* with the 11.66 ± 0.57 mm and 14.00 ± 1.00 mm, respectively. The smallest zone of inhibition is seen against *E. coli* with all the three extracts hexane (7.00 ± 1.00 mm), methanol (5.67 ± 0.57 mm), and aqueous (6.00 ± 1.00 mm).[71] Anti-fungal & bacterial activities examined against 7 pathogens with three extracts of leaves of different solvents. Only ethanolic extract exhibits antifungal activity against *P. Chrysogenum* and *F. oxysporum*15.0 ± 0.20 mm & 12.0 ± 0.25 mm, respectively. Ethanolic extract shows maximum zone of inhibition of antibacterial activity against *S. typhi, K. pneumonia & P. vulgaris* 16.5 ± 0.25, 16.0 ± 0.18 & 12.0±0.29, respectively. Aqueous extract of leaves against *E. coli* exhibits less minimum zone of inhibition among all (5.0 ± 0.26).[72]

Cytotoxic and anti-tumor activity: *E. royleana* plant shows good potential for antitumor and cytotoxic activity. I*n-vitro* activities performed on (Caco-2 cells), (CMT1 cells, MPG cells), HepG2 cells, BALB/3T3 cells and by brine shrimp lethality test depicts the good results. The brine shrimp mortality test is an effective, accurate and economical method for the evaluation of cytotoxicity. It is used to evaluate the cytotoxicity potential of a fresh hexane extract of whole plant.

Table 2. Ethnomedicinal uses in India

S. No	Place	Local name	Part use	Uses	Treatment	References
				Arunachal Pradesh		
1.	Lohit		S	Cold (PFs)	Burning stem for gastritis& latex for dermatological disorder.	54
				Anaemia (DFs)/ Powder	Juice and paste of leaves is for fever and cuts.	
				Haryana		
2.	Hisar	Dandathor	L	Skin ailments (allergy)	-	55
				Himachal Pradesh		
3.	Hamirpur	Chu, chui, thor	L,S, R	Stimulating ovulation and tail infection in animals.	-	56
				snake bite treatment.	Decoction of roots and kali mirch is used.	
	Shimla			Medicinal and ornamental value.		57
	Mandi	Chuhna	L,S	cuts, burns, itching, abscesses, allergies	Small pieces of stem are fried in mustard oil till amount of oil reduced to 1/10th of the original.	22
	Solan	Chhuro	L,S	Cure painful areas and as a cavity filler.	Latex is filled in the hollow cavities of decayed tooth.	59
				Jammu & Kashmir		
4.	Kupwara	Guresochal	F, L	Skin eruptions, wounds	Leaves are crushed to make paste	60
	NWHR		WP	Antihelminitic properties	-	61
	NWHR	-	L	fracture	Latex is use by topical method on animals	62 63
				Mizoram		
5.	Mizoram	Chawng	P, F	To treat liver diseases, boils, warts	Latex is used externally for ring worm, rheumatism, boils, warts, etc. Juice of heated leaves is applied to earache.	64
				Orissa		
6.	Orissa	jasiju/ Danda, Thur		Anti-inflammatory, anti-arthritis	-	65
				Tamil Nadu		
7.	Nilgiris biosphere	Nanda, Danda thor		Male impotency, anti-helmintic.	Latex used to treat male impotency and as hair tonic.	21
				Uttar Pradesh		
8.	Garhwal Himalayas	-	S	Cataract of cattle.	-	66
				Uttrakhand		
9.	Tehri Grahwal	Sulla	F, L	Bio-fencing, cuts and wounds.	Latex is used externally for ring worm. Juice of leaves is applied to earache.	58
	Dhundsir Gad		L	Cuts and wounds	Latex is applied externally.	67
	Ukimath	Sulla	B, L	Ear pain	Juice is applied externally as eardrop and during secretion from ears.	68
	Kedarnath forest division	Sulla	L	-	Latex is used as an antiseptic on cuts and wounds.	67
	Almora	khyun	S	Tooth cavity, tooth ache	Milky extract secreted by stem is directly applied on affected tooth	69
				West Bengal		
10.	Eastern Himalayas	Siwri	L	Cold and asthma.	-	70

Abbreviations: WP-whole plant; L- latex; S-stem; F-leaf; R-root; B-bark

Minimum and maximum mortality (6.66% and 61.66%) were observed at 25 ppm and 800 ppm. Anti-tumor activity of different concentrations (25-800 mg/ml) of methanolic, hexane and aqueous extracts of fresh plantwas studied as a potato disc assay. The percentage of tumor inhibition increases with increase in the concentration of plant extracts. Maximum tumor inhibition was studied with hexane extract (63.49 ± 1.81%), followed by methanol (56.01 ± 1.34%) and water extracts (45.87 ± 2.71%).[74] Anti-tumor activity performed on (HEGP2)cell line and (BALB/3T3) cells of a lyophilized latex which shows medium toxic effect on HEGP2 cell line with an IC_{50} of 80.2 µg/mL and has, a weak harmful impact of BALB/3T3 cells with an IC_{50} of 352.1 µg/mL. Results explain that lyophilized latex may use as a remedy for the treatment of liver cancer.[76] Non flowering aerial part of a plant macerated with the methanol solvent and further tested for the human hepatoma (HepG2) cell, human breast adenocarcinoma (MCF-7) cell and (Caco-2)cell. Plant methanolic extract is active towards human colon adenocarcinoma cells with an IC_{50} 9.1 (µg/mL) and no response to the other 2 cells.[73] Hexane and ethanolic extract of a plant is tested for the *in-vitro* and *in-vivo* canine mammary gland tumors (CMT1 and MPG cells) and exhibits good result. *In-vitro* results explain that it could inhibit cell proliferation and colony formation and suppress the tumor cell growth which results from cell cycle arrest and necrosis. And, the in vivo results explain that it could reduce the size of solid tumors and exhibits low toxicity in cMGT bearing nude mice. Hence, the findings prove that it has potential anti-tumor effects of canine mammary gland tumors.[80]

Other activities: *E. royleana Boiss*. stem extracts of methanol and DCM solvents tested for inhibitory potential in vivo and *in-vitro* blood glucose levels, as well as biochemical activity against α-amylase. The potential results recorded with the methanolic extract. Efficient results recorded at 500 mg/kg of methanolic stem extract (*in-vivo*). *In vitro* α- amylase inhibition shows IC_{50} value of methanolic extract 7.753 mg/mL which was better than the DCM extract 10.28 mg/mL.[75] Ethyl acetate

Table 3. Biological activity of extracts.

S. No	Biological activity	Activity on/against	Extraction method	Extractive solvent	IC_{50}/ mean ± SD	References
			Aerial part			
1.	Cytotoxicity	Caco-2 cells	Maceration	MeOH	9.1 (µg/mL)	70
			Whole plant			
2.	Antioxidant	DPPH	Orbital shaker	Hexane	0.38 (mg/mL)	71
				MeOH	0.58 (mg/mL)	
				Aqueous	1.13 (mg/mL)	
	Anti-tumor	Potato disc assay		Hexane	63.49±1.81%	
				MeOH	56.01±1.34%	
				Aqueous	45.87±2.71%	
	Cytotoxic	Brine shrimp lethal test		Hexane.	6.66% at 25 ppm 61.6% at 800 ppm	
	Antimicrobial	*E. coli*		Hexane	7.00 ± 1.00 mm	
				MeOH	5.67 ± 0.57 mm	
				Aqueous	6.00 ± 1.00 mm	
		B. subtilis		Hexane	12.00 ± 0.57 mm	
				MeOH	10.67 ± 0.57 mm	
				Aqueous	8.33 ± 0.00 mm	
		P.multocida		Hexane	10.33 ± 0.57 mm	
				MeOH	8.33 ± 0.57 mm	
				Aqueous	8.00 ± 1.00 mm	
		A.niger		Hexane	14.00 ± 1.00 mm	
				MeOH	11.66 ± 0.57 mm	
				Aqueous	9.33 ± 0.57 mm	
		F.Solnai		Hexane	10.33 ± 0.57 mm	
				MeOH	10.00 ± 1.00 mm	
				Aqueous	8.66 ± 0.57 mm	
			Leaves			
3.	Antifungal	*P. chrysogenum*	Shaking	PE	NA	72
				EtOH	15.0 ± 0.20 mm	
				Aqueous	NA	
		F. oxysporum		PE	NA	
				EtOH	12.0 ± 0.25 mm	
				Aqueous	NA	
	Antibacterial	*E. coli*		PE	8.5 ± 0.23 mm	
				EtOH	7.0 ± 0.25 mm	
				Aqueous	5.0 ± 0.26 mm	
		S. pneumonia		PE	6.0 ± 0.15 mm	
				EtOH	8.0 ± 0.16 mm	
				Aqueous	9.0 ± 0.19 mm	
		S. typhi		PE	11.0 ± 0.26 mm	
				EtOH	16.5 ± 0.25 mm	
				Aqueous	12.0 ± 0.22 mm	
		K. pneumonia		PE	12.0 ± 0.16 mm	
				Et	16.0 ± 0.18 mm	
				Aqueous	9.0 ± 0.16 mm	
		P. vulgaris		PE	6.5 ± 0.22 mm	
				EtOH	12.0±0.29 mm	
				Aqueous	7.0 ± 0.26 mm	
			Latex			
4.	Immunosuppressive prop.	*In-vitro & in-vivo*	-	85% EtOH (EtOAc fr.)	NA	28
5.	Anti–inflammatory/ anti-arthritic	Rats and mice	-	Hydro soluble fr.	NA	25
6.	Anti- inflammatory / anti-arthritis	Rats and mice	-	85% EtOH (EtOAc fr.)	NA	68
7.	antipyretic	Rats and rabbits	-	85% EtOH (EtOAc fr.)	NA	70
8.	antioxidant	DPPH	lyophillization	-	96.3 µg/mL	73
		NO scavenging			1.87 mg/mL	
	Cytotoxic activity	HEPG2			80.2 µg/mL	
		BALB/3T3			352.1 µg/mL	
9.	Pro-inflammatory	Mouse ear	-	MeOH	-	74
			Stem			
10.	Antioxidant	DPPH	Maceration by shaking	MeOH	70.1 µg/mL	75
				DCM	112.5 µg/mL	
	Anti-diabetic	α-amylase		MeOH	7.75 µg/mL	
				DCM	10.28 µg/mL	
11.	Allelopathic effect	Seeds	Shaking incubator	Aqueous	-	76
12.	Anti-tumor	CMT1 cells	-	Hexane	4.5 ± 2.5 mm	77
				EtOH	14 ±5.2 mm	
		MPG cells		Hexane	3.5 ± 1.5 mm	
				EtOH	12 ± 3.1 mm	

Abbreviations: PE- Petroleum ether; DCM- Dichloromethane; EtOAc- Ethyl acetate; EtOH- Ethanol; MeOH- Methanol; Fr.- Fraction

fraction of latex showed antipyretic activity by the yeast induced hyperthermic test in rats and pyrogen induced hyperpyrexia in rabbits. The oral dosages of 50, 100, and 200 mg/kg, it decreased the pyrexia-induced rabbits body temperatures, although the effect peaked in the first two hours and then progressively diminished. Fraction also shows weak analgesic activity. Results conclude that these activities may also be due to inhibition of prostaglandins.[69] Aqueous extract of stem has the potential to be used as an organic fertilizer, which helps in enhancing the productivity of important plants.[76] Ethyl acetate fraction of latex shows immunosuppressive property by *in-vitro* and *in-vivo* experiment. It suppresses cell mediated immunity and humoral immune responses also.[28] Hydro-soluble fraction and ethyl acetate fraction of latex analyzed for the anti-arthritic activity performed on rats and mice. The ethyl acetate fraction showed inhibition of increase of erythrocyte sedimentation rate which is the common feature of arthritic, and it lowered

Figure 4. *Traditional uses of the plant for various diseases and uses. Ailments in others section includes earache, toothache, bladder stones, snake bite, cataract, arthritis, anaemia.*

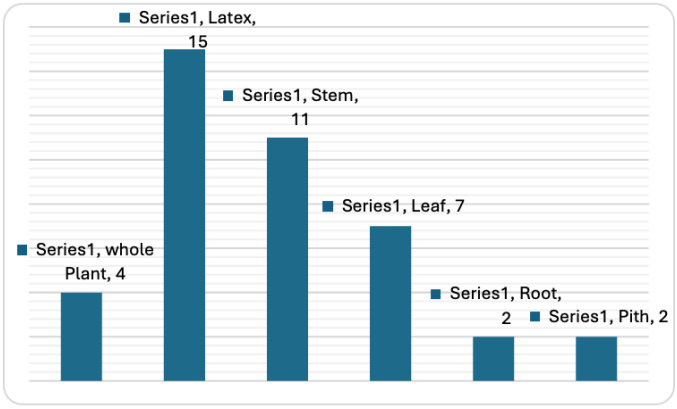

Figure 5. *Plant parts of E. royleana species used traditionally for the treatment of various ailments.*

the induced arthritic increase in total leucocyte count. Hydro-soluble fraction showed dose dependent inhibitory activity in formaldehyde induced arthritis.[25,68] Chemometric multivariate analysis of plant parts of *E. royleana* revealed the chemotaxonomic significance and thus the metabolite correlated antioxidant and anti-tyrosinase inhibition activities performed of solvent – dependent extraction of different plant parts. Among all stem extracts of *E. royleana* demonstrate potent tyrosinase inhibition (IC50 0.21–0.45 µg/mL), significantly outperforming both flower and leaf parts, revealing the potential of *E. royleana* plant parts.[86]

The biological activities showed the potent nature of the plant and can be used for the clinical analysis. The potential for bioactivities can be attributed to the bioactive components present in the plant. Overall, study of activities shows that organic extracts of the plant exhibit biological activities which might be helpful in prevention of various diseases and can be used in alternative system of medicine.

2.3. Phytochemistry

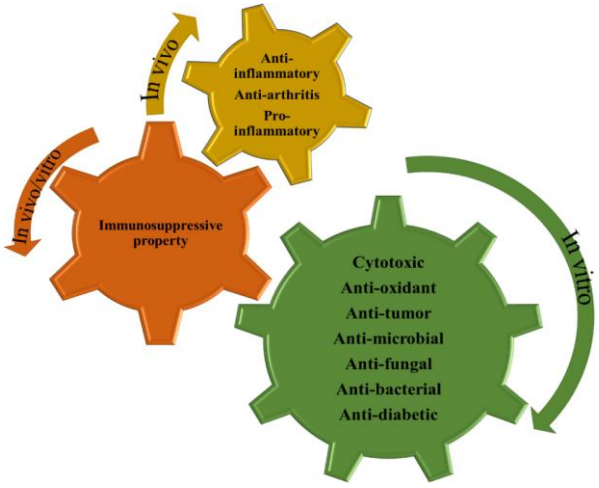

Figure 6. *Biological activity of plant extracts.*

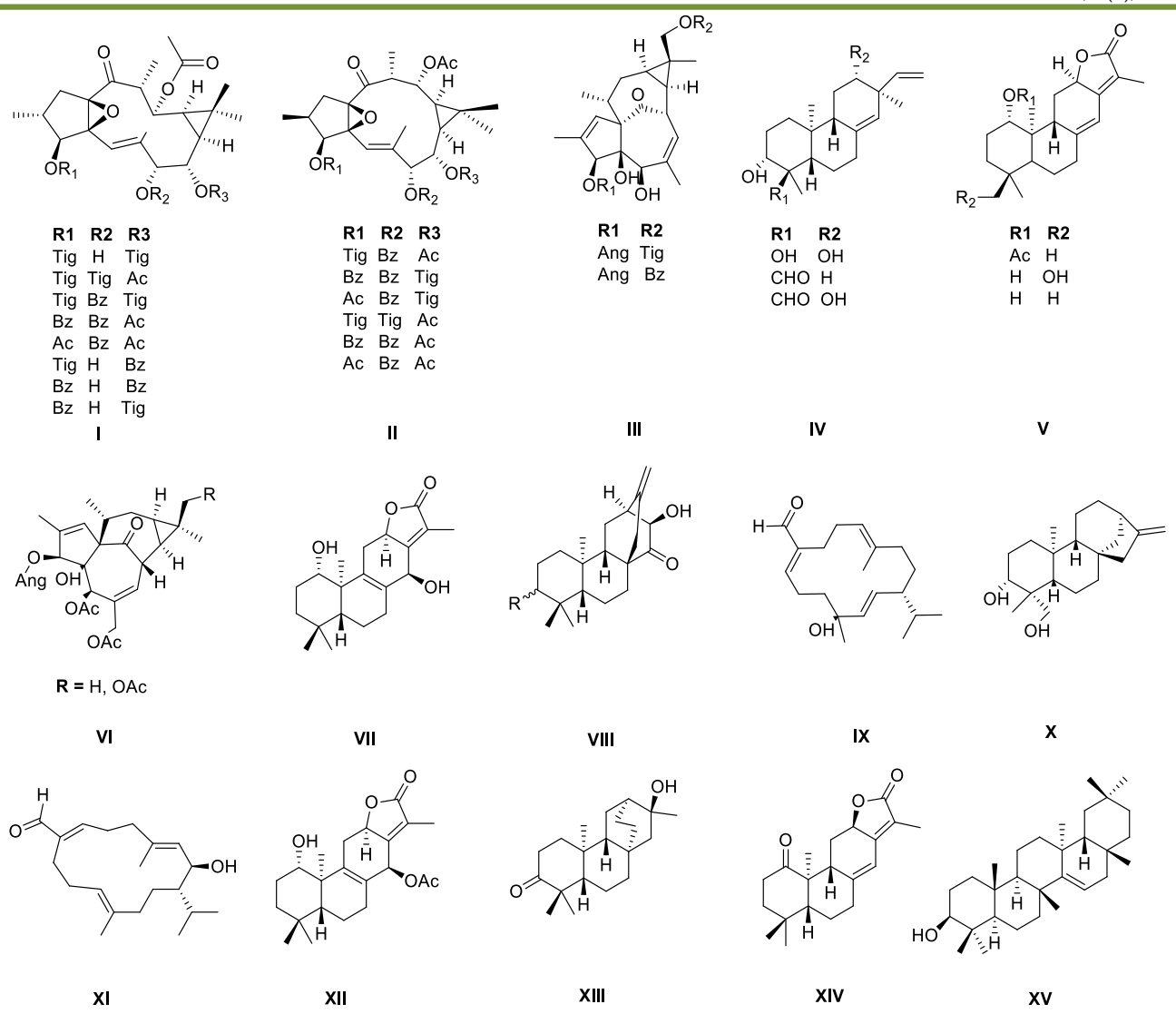

Figure 7. *Lathyrane diterpenes (I), Ingol lathyrane type diterpenes (II), Ingenane type diterpenes (III), ent-isompirane type (IV), ent-abietane type diterpenes (V), Ingenol diterpenoid (VI), Eurifoloid D (VII), ent-3β,13S-dihydroxyatis-16-en-14- one (VIII) Euphoroylean A (IX), ent-kaurane tpe diterpens (X), Euphoroylean B (XI) Eurifoloid E (XII), ent-16a-hydroxy-atisane-3-one (XIII), euphorantone B (XIV) (3b,23Z)-9,19-cyclolanost-23-ene-3,25-diol (XV)*

Chemical constituents: Several compounds of diterpenoids class have been isolated from the *E. royleana* plant parts. Various processes such as extraction, reflux, partitioning etc. (with different solvents) were carried out to isolate compounds from different parts (Aerial part, stem, whole plant and latex) and further investigated for their bioactivities. Numerous studies have been carried out on different parts of *E. royleana* plant from which various diterpenes have been isolated. Latex subjected to extraction and partitioning resulted in to mixture of four tetra esters of the macrocyclic diterpenes ingol and 4 tri-

Table 4. Phytoconstituents and their biological activities.

S. No.	Plant part	Extraction method	Extractive solvent	Phytoconstituents	Category	Bioactivity	References
1.	Latex	Extraction and partitioning	MeOH	Mixture of 4 tetra-esters Mixture of 4 tri-esters	diterpene	-	74
2.	Aerial part	-	70% aq.Me_2CO	10 new ingol lathyrane and 2 known ingenol	diterpenes	Anti angiogenic	78
3.	Stem	Reflux	MeOH	2 new ingenane 2 new ent-atisane 2 new ent-kaurane 2 new ent-abietane 1 ent-isopimarane 12 known compounds	diterpenes	Inhibiting NO production in BV-2 cells	31
4.	Whole plant	Extraction and partitioning	EtOH	8 new compounds 22 known compounds	diterpenes	MDR modulator	30
5.	Aerial part	-	90% aq. EtOH	3 new ingol 3 known ingol	diterpenes	Cytotoxicity	79
6.	Whole plant	-	95% EtOH Fr.	2 new ingenane and ingol	Diterpenes and triterpenes	*In-vitro* cytotoxicity	77
7.	Stem	Extraction and partitioning	Aq. EtOH	2 new triterpenoids	Triterpenes	-	82

Abbreviations: MeOH: Methanol; Aq.: aqueous; EtOH: Ethanol; Fr.: fraction; Me_2CO: Acetone

Table 5. Toxic effects of plant.

S. No.	Toxicity	Plant part	References
1.	Piscicidal (time and dose-dependent) Muricidal (dose-dependent)	latex	
2.	Piscicidal (anti-acetyl cholinestrase)	Stem bark	24
3.	Allergic, nausea and skin itches on being contact with the whole plant	Whole plant	84
4.	Injury to the eye by sap	latex	81
5.	Toxicity to snails	latex	82

esters of the diterpenes[74] Also, as aerial part of the plant was treated with 70% aqueous acetone resulted ten new ingol lathyrane and two known ingenol, that possess anti-angiogenic activity.[78] Similarly, when stem is subjected to reflux with methanol as an extractive solvent, two new ingenane, two new ent-atisane, two new ent-kaurane, two new ent-abietane, one ent-isopimarane and twelve known compounds that are reported for the inhibition of NO production in BV-2 cells.[31] In 2020, eight new compounds were isolated from whole plant with ethanolic extracts containing 22 known compounds. ingol-3,7,12-triacetate-8-benzoate, showed most active MDR modulator activity with no obvious cytotoxicity, and able to enhance the efficacy of anticancer drug.[30] Cytotoxic activities on HL-60 by MTT assay performed of three new and three known ingol diterpenes isolated from 90% ethanolic extract of aerial part.[79] Two new ingenane & ingol and eleven known compounds from ethyl acetate fraction of whole plant isolated and tested for the cytotoxic activity on A549 lung cancer cell line. Among all, two previously known triterpenoids showed the moderate activity.[80] Table 4 illustrates the chemical components isolated from the plant with their biological activities.

2.4. Toxicity of *Euphorbia royleana*

E. royleana sap caused a severe conjunctival, corneal, and iritis inflammatory reaction, but not dermatitis. The acute reaction may be due to stronger penetration of the sap alkaloids into the cornea.[81] Correlation of the anti-acetyl cholinesterase and molluscidal activity of the latex extract is studied *in-vivo* and *in-vitro*. Study shows that the extract contains a potent anti-acetyl cholinsetrase substance and shows molluscidal activity. So, it does not conclude that its mortal to snail but it is due to strong anti-acetylcholinesterase activity. The substance which is responsible for the activity is temperature resistant and soluble both in water and organic solvents.[82] The findings from an article on piscicidal and antilethal activity of latex against the freshwater snakehead fish Channa punctatus and the Swiss albino mice Mus musculus suggests that the latex should only be used in moderate doses. Latex treatment is toxic to both test animals and is proven by the lethal concentration values. The toxicity of the latex treatment to the freshwater fish Channa punctatus was both time and dose dependent. However, muscle toxicity in mice was only dose-dependent and greater than in fish.[83] Table 5 illustrates toxic nature of plant parts.

3. Discussion

The first experimental evidence to prove traditional use for the treatment of fever is presented by[69] which was conducted on rats and mice by using *in-vivo* method and results in that the ethyl acetate fraction of latex shows antipyretic activity.[40,42] However, the number of studies is low and present a gap in order to conclude the antipyretic activity because of unknown responsible constituents. Another traditional use supported by experimental research is the anti-inflammatory activity and according to the reviewed literature, latex part is used for the treatment.[50,62] Hydro-soluble and ethyl acetate fraction of latex shows the biological activity performed on rats and mice by *in-vivo*. However, authors did not specify the compounds exerting the anti-inflammatory activity performed on rats and mice.[25,68,74] Gastroprotective properties were shown traditionally by parts of the plant in Nepal and in India[42,46,61,42] and this biological activity is scientifically proved by performing cytotoxic activity of lyophilized latex and methanolic extract of aerial part on HepG2 cell by MTT assay and against Caco-2 cells respectively.[70,73] However, there is still a need to explore the plant to treat various ailments of gastro-intestinal which all are mentioned traditionally and the chemical constituents. Fracture body parts are being treated by the leaves and the latex of the plant in Kaski region of Nepal and in Jammu & Kashmir since ancestral practices[46,59] and this property of plant to heal bones have been examined by *in-vivo* method of latex part on rats and mice as antiarthritic activity and showed positive results.[68]

Limitations

E. royleana has a variety of medical applications, but it also has certain limits. The latex of the plant shows toxic effects and causes irritation or swelling to skin or loss of eyesight. Therefore, while handling gloves should be used; the face should be protected, and the plant should be kept away from kids. Preventive measures must be taken to overcome health related problems.

4. Conclusion

Euphorbia royleana is a medicinally significant cactus-like plant whose various parts have been traditionally employed across diverse ethnomedical systems for the treatment. Plants parts of species were also found to be used for preparation of human and livestock remedies. Traditionally, latex part of the plant is highly used followed by the stem and then the other different parts for various remedies. Insufficient knowledge of the *in vitro* and *in-vivo* biological activities of *E. royleana*, as well as its chemical constituents present an unfair obstacle to the development of novel therapeutic approaches that may aid in the management of diseases like diabetes and cancer. There is a need for more research endeavors to validate the mechanism of action of *E. royleana* and its constituents and subsequent clinical trials should be conducted to support their pharmacological efficacies and their long-term toxicity effects. Overall, *E. royleana* appears to be a promising species in traditional medicines and thus spreads wide array of pharmacological activities and potential therapeutic benefits.

Biographical Information

Ms. Pallavi Kumari is a Ph.D. Scholar at Career Point University, Hamirpur, India. She completed her master's degree in Chemical Sciences from Chandigarh University in 2020. Her doctoral research is being carried out in collaboration with CSIR-Institute of Himalayan Bioresource Technology, focusing on the phytochemical profiling, biological evaluation, and therapeutic potential of *Euphorbia royleana*. Her research interests include natural products chemistry, medicinal plants, phytochemistry of bioactive natural compounds. She has actively participated in national and international conferences and is engaged in exploring plant-derived molecules for pharmaceutical applications.

Dr. Rishabh Kaundal is a researcher in natural product chemistry and phytopharmacology, specializing in Himalayan medicinal plants. He obtained his Ph.D. from CSIR–IHBT, Palampur, focusing on *Viola canescens*. His expertise includes metabolite profiling, UPLC-PDA and UHPLC-QTOF-MS analysis, and bioactivity evaluation. His research integrates phytochemistry with pharmacological and in silico studies. He is currently an Institute Postdoctoral Fellow at IIT (BHU), Varanasi, working on bioactive natural products and metabolomics-driven applications.

Prof. Yogesh Kumar Walia was born in Hamirpur, Himachal Pradesh, India in 1980. He received his B.Sc. degree from the Himachal Pradesh University Shimla in 2000. In 2004 he received his M.Sc. degree from the Barkatullah University (formerly Bhopal University), Bhopal, India. In 2010 he received his Ph.D. degree from the Barkatullah University (formerly Bhopal University), Bhopal, India. His contribution is in synthetic bioorganic chemistry, environmental protection and natural products as published in peer review journals and published more than forty research papers. Presently he is working as Professor of organic chemistry at Career Point University Hamirpur, India and supervising Eight Ph.D. research scholars on nanosynthesis, water pollution analysis, isolation of natural products from Euphorbia royleana and Rhynchostylis retusa etc.

Author Contribution Declaration & Information

Contribution
Pallavi Kumari: Conceptualisation, Data curation, Writing – original draft. **Rishabh Kaundal:** Data curation. **Yogesh Kumar Walia:** Conceptualisation, finalization.

Corresponding Author
Prof. Yogesh Kumar Walia - Department of Chemistry, School of Basic & Applied Sciences, Career Point University, Hamirpur-176041, Himachal Pradesh, India.
Email: yogesh.che@cpuh.in
https://orcid.org/0000-0002-3276-262X

Author
Ms. Pallavi Kumari - Department of Chemistry, School of Basic & Applied Sciences, Career Point University, Hamirpur-176041, Himachal Pradesh, India.
https://orcid.org/0009-0003-3101-3824

Dr. Rishabh Kaundal- Chemical Technology Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061, Himachal Pradesh, India.
https://orcid.org/0000-0002-4470-1453

Data Availability Declaration

No new data were created, hence data sharing is not applicable.

Declaration of Conflict of Interest

The authors declare no competing financial interest.

Acknowledgements

Thanks to Career Point University, Hamirpur for providing academic support and facilities that enable the successful completion of this review article.

References

1. M. Kargıoglu, S. Cenkci, A. Serteser, N. Evliyaoglu, M. Konuk, M. S. Kök, Y. Bagcı. An ethnobotanical survey of Inner-West Anatolia. *Hum. Eco.* **2008**, *36*, 763. https://doi.org/10.1007/s10745-008-9198-x
2. S. Verma, S. P. Singh. Current and future status of herbal medicines. *Vete. World*. **2008**, *1*, 347. https://doi.org/10.5455/vetworld.2008.347-350
3. C. T. Che, V. George, T. P. Ijinu, P. Pushpangadan, K. Andrae-Marobela. Traditional medicine. In *Pharmacognosy*. **2017**, 15-30. https://doi.org/10.1016/B978-0-12-802104-0.00002-0
4. A. G. Atanasov, B. Waltenberger, E. M. Pferschy, T. Linder, C. Wawrosch, P. Uhirin, V. Temm, L. Wang, S. Schwaiger, E. H. Heiss, J. M. Rollinger, D. Schuster, J. M. Breuss, V. Bochkoy, M. D. Milhovilovic, B. Kopp, R. Bauer, V. M. Dirsch, H. Stuppner. Discovery and resupply of pharmacologically active plant-derived natural products: A review. *Biotechnol. Adv.* **2015**, *33*,1583. https://doi.org/10.1016/j.biotechadv.2015.08.001
5. A. L. Harvey, R. Edrada-Ebel, R. J. Quinn. The re-emergence of natural products for drug discovery in the genomics era. *Nat. Rev. Drug Discov.* **2015**, *14*,1. https://doi.org/10.1038/nrd4510
6. J. T. Mwine, P. V. Damme. Why do Euphorbiaceae tick as medicinal plants? A review of the Euphorbiaceae family and its medicinal features. *J. Med. Plants Res.,* **2011**, *5*, 652.
7. D. Kemboi, X. Peter, M. Langat, J. Tembu. A review of the ethnomedicinal uses, biological activities, and triterpenoids of *Euphorbia* species. *Mol.,* **2020**, *25*, 1. https://doi.org/10.3390/molecules25174019
8. G. L. Webster. Classification of the Euphorbiaceae. *Ann. Missouri Bot. Gard*., **1994**, *81*, 3. https://doi.org/10.2307/2399908
9. I. K. R. Kgosiemang, R. Lefojane, A.M. Adegoke, O. Ogunyemi, S. S. Mashele, M. P. Sekhoacha. Pharmacological significance, medicinal use, and toxicity of extracted and isolated compounds from Euphorbia species found in southern Africa: A review. *Plants* **2025**, *14*, 469. https://doi.org/10.3390/plants14030469
10. A. Vasas, J. Hohmann. *Euphorbia* diterpenes: isolation, structure, biological activity, and synthesis (2008-2012). *Chem Rev.* **2014**, *114*, 8579. https://doi.org/10.1021/cr400541j
11. P. Bigoniya, A. C. Rana. A Comprehensive Phyto-pharmacological Review of *Euphorbia* neriifolia Linn *Pharmacogn Rev.,* **2008**, *2*, 57. https://www.cabidigitallibrary.org/doi/full/10.5555/20093039499
12. B. Salehi, M. Iriti, S. Vitalini, H. Antolak, E. Pawlikowska, D. Kregiel, J. Sharifi-Rad, S. I. Oyeleye, A. O. Ademiluyi, K. Czopek, M. Staniak, L. Custodio, E. Coy-Barrera, A. Segura-Carretero, M. D. L. L. Cádiz-Gurrea, R. Capasso, w. C. Cho, A. M. L. Seca. *Euphorbia*- derived natural products with potential for use in health maintenance. *Euphorbia*-Derived Natural Products with Potential for Use in Health Maintenance. *Biomolecules* **2019**, *9*, 1. https://doi.org/10.3390/biom9080337
13. D. S. Seigler. Phytochemistry and Systematics of the Euphorbiaceae. *Ann. MissouriBot.Gard.***1994**, *81*, 380. https://doi.org/10.2307/2992104
14. Q. W. Shi, X. H. Su, H. Kiyota. Chemical and Pharmacological Research of the Plants in Genus *Euphorbia*. *Chem. Rev.* **2008**, *108*, 4295. https://doi.org/10.1021/cr078350s
15. A. O. Pascal, A. E. V. Bertrand, T. Esaie, H. A. M. Sylvie, A. Y. Eloi. A review of the ethnomedical uses, phytochemistry, and pharmacology of the *Euphorbia* genus. *J. Pharm. Innov.,* **2017**, *6*,34.
16. S. Kumar, R. Malhotra, D. Kumar. *Euphorbia hirta*: Its chemistry, traditional and medicinal uses, and pharmacological activities. *Pharmacogn Rev.* **2010**, *4*, 58. https://doi.org/10.4103/0973-7847.65327
17. W. F. Zheng, Z. Cui, Q. X. Zhu. Cytotoxicity and antiviral activity of the compounds from *Euphorbia kansui*. *Planta Medica.,* **1998**, *64,* 754. https://doi.org/10.1055/s-2006-957574
18. Q. Zhang, Q. R. Zhou, J. W. Lou, P. D. Chen, W. Yao, W. W. Tao, Y. P. Tang, G. C. Dai, K. Wang, L. Zhang. Chemical Constituents from *Euphorbia kansui*. *Molecules* **2017**, *22*, 2176. https://doi.org/10.3390/molecules22122176

19. C. Burlakoti, R. M. Kunwar. Folk herbal medicines of mahakali watershed area, Nepal. *Medicinal plants in Nepal: An anthology of contemporary research,* **2008**, 187-193.
20. M. V. N. L. Chaitanya, P. Suresh. The Neglected Anticancer Phytoceutical Treasures from the Nilgiris Biosphere: A Short Review, *J. Pharm. Res. Int.,* **2018**, *22*, 1. https://doi.org/10.9734/JPRI/2018/40529
21. S. K. Sood, S. Thakur. Ethnobotany of Rewalsar Himalaya. Ph.D. thesis. **2004**.
22. S. Aditya. A revision of geophytic *Euphorbia* species from India. *Euphorbia world*, **2010**, *6*,18.
23. M. Sabeen, S. S. Ahmad. Exploring the Folk Medicinal Flora of AbbotabadCity, Pakistan. *Ethnobotan. Leafl*. **2009**, *13*, 810.
24. S. Tiwari, A. V. Singh. Piscicidal and anti-acetylcholinesterase activity of *Euphorbia royleana* stem bark extracts against freshwater common predatory fish Channa punctatus. *Environ. Toxicol. Pharmacol*., **2004**, *181*, 47. https://doi.org/10.1016/j.etap.2004.05.001
25. S. Bani, A. Kaul, B. S. Jaggi, K. A. Suri, O. P. Suri, O. P. Sharma. Anti-inflammatory activity of the hydrosoluble fraction of *Euphorbia royleana* latex. *Fitoterapia*. **2000**, *71*, 655. https://doi.org/10.1016/S0367-326X(00)00225-2
26. P. Kumari, R. Kaundal, R. Kumar, Y. K. Walia, D. Kumar. Metabolome Analysis and Functional Activities of *Euphorbia royleana* Boiss. Indicating Potential Health Benefits. *Chem & Biod*., **2026**, *23*, 03217. https://doi.org/10.1002/cbdv.202503217
27. R. Ullah, S. A. Jan, M. N. Khan, M. Nazish, A. Kamal, A. Kaplan, H. M. Yehia, K. M. Alarjani, R. Alkasir, W. Zaman. *Euphorbia royleana* Boiss derived silver nanoparticles and their applications as a nanotherapeutic agent to control microbial and oxidative stress-originated diseases. *Pharmaceuticals* **2023**, *16*, 1413. https://doi.org/10.3390/ph16101413
28. S. Bani, S. Kaul, B. Khan, S. F. Ahmad, K. A. Suri, N. K. Satti, M. Amina, G. N. Qazi. Immunosuppressive properties of an ethyl acetate fraction from *Euphorbia royleana*. *J. Ethnopharmacol*., **2005**, *99*,185. https://doi.org/10.1016/j.jep.2004.12.017
29. The Plant List. Version 1.1. Published on the Internet; http://www.theplantlist.org/. **2013**.
30. S. Shakera, J. Sanga, X. L. Yana, R. Fana, G. Tanga, Y. Xub, S. Yina. Diterpenoids from *Euphorbia royleana* reverse P-glycoprotein-mediated multidrug resistance in cancer cells. *Phytochemistry* **2020**, *176*, 112395. https://doi.org/10.1016/j.phytochem.2020.112395
31. P. Wang, C. Xie, L. An, X. Yang, Y. Xi, S. Yuan, C. Zhang, M. Tuerhong, D. Jin, D. Lee, J. Zhang, Y. Ohizumi, J. Xu, Y. Guo. Bioactive diterpenoids from the stems of *Euphorbia royleana*. *J. Nat. Prod.,* **2019**, *82*, 183. https://doi.org/10.1021/acs.jnatprod.8b00493
32. M. R. Paudel, B. Paudel, H. D. Bhattarai, R. M. Kunwar, H. A. Jan, M. A. Turi, R. W. Bussmann, N. Y. Paniagua-Zambrana. *Euphorbia hirta*L., *Euphorbia Pilosa* L., *Euphorbia royleana* Boiss. *Ethnobot. Himal.,* **2021**, 1-14. https://doi.org/10.1007/978-3-030-45597-2_97-2
33. *Euphorbia royleana* Boissier in A. Candolle, Prodr. **1862**, *15*, 83.
34. Z. Wu, P. H. Raven, D. Hong. *Flora of China* (**2011**). Beijing/St. Louis. Science Press/Missouri Botanical Garden Press. 289-300.
35. *Euphorbia royleana* Boiss., Flora of Pakistan, Tropicos. org. **2011**. https://legacy.tropicos.org/Project/Pakistan
36. N. A. Harriman. Flora of Pakistan. *Economic Botany*. **2004**, *58*, 742. https://doi.org/10.1663/0013-0001(2004)058[0742:BREDFA]2.0.CO;2
37. C. Y. Wu, P. H. Raven, D. Y. Hong (eds.) *Flora of China* (**2003**). Science Press & Missouri Botanical Garden Press, Beijing & St. Louis.
38. X. G. Lai, Y. B. Yang, X. L. Shan. The investigation of euphorbiaceous medicinal plants in southern china. *Economic Botany* **2004**, *58*, S307. https://doi.org/10.1663/0013-0001(2004)58[S307:TIOEMP]2.0.CO;2
39. B. Poudel, J. Bhandari, A. Poudel, D. Gautam. Ethnomedicinal use of Common Garden Species in Arghakhanchi district, Western Nepal. *Asian J. Pharma.,* **2021**, *4*, 31.
40. H. Giri, M. Rajbhandari. Phytochemical Evaluation of Some Medicinal Plants of Pyuthan District of Nepal. *Nepal J. Sci. Technol.,* **2020**, *19*, 97. https://doi.org/10.3126/njst.v19i1.29789
41. N. P. Manandhar. An inventory of some herbal drugs of myagdi district, nepal. *Economic botany.* **1995**, *49*, 371. https://doi.org/10.1007/BF02863087
42. M. B. Rokaya, Y. Uprety, R. C. Poudel, B. Timsina, Z. Münzbergová, H. Asselin, A. Tiwari, S. S. Shrestha, S. R. Sigdel. Traditional uses of medicinal plants in gastrointestinal disorders in Nepal. *J. Ethnopharma.,* **2014**, *158*, 221. https://doi.org/10.1016/j.jep.2014.10.014
43. R. M. Kunwar, K. Shrestha, S. Malla, T. Acharya, A. J. Sementelli, D. Kutal, R. W. Bussmann. Relation of medicinal plants, their use patterns and availability in the lower Kailash Sacred Landscape, Nepal. *Ethnobo. Res. Appl.,* **2019**, *18*, 1. https://doi.org/10.32859/era.18.7.1-14
44. A. G. Singh, M. P. Panthi, D. D. Tewari. Ethno Medicinal Plants Used by the Tharu and Magar Communities of Rupandehi District, Western Nepal. *Current Botany* **2011**, *2*, 30.
45. J. P. R. Thorn, T. F. Thornton, A. Helfgott, K. J. Willis. Indigenous uses of wild and tended plant biodiversity maintain ecosystem services in agricultural landscapes of the Terai Plains of Nepal. *J. Ethnobiol. Ethnomed*., **2020**, *16*, 33. https://doi.org/10.1186/s13002-020-00382-4
46. N. D. Bastakoti. An ethnobotanical study of medicinal plants used by kumal and Gandharva community of pokhara metropolis, kaski, Nepal. *Himalayan biodiversity* **2019**, *7*, 19. https://doi.org/10.3126/hebids.v7i1.40186
47. K. R. Bhattarai. Ethnobotanical study of plants used by Thami community in Ilam District, eastern Nepal. *Our Nature*, **2018**, *16*, 55. https://doi.org/10.3126/on.v16i1.22123
48. A. A. Shah, Z. Khan, M. Ramzan, R. Saba. Ethnoecological Studies of Herbs and Shrubs of Miani Sahib Graveyard, Lahore City, Punjab, Pakistan. *J. bioresour. manag.,* **2016**, *3*, 33. https://doi.org/10.35691/JBM.6102.0052
49. A. Jabeen, M. A. Khan, M. Ahmad, M. Zafar, F. Ahmad. Indigenous uses of economically important flora of Margallah Hills National Park, Islamabad, Pakistan. *Afric. J. Biotechnol.* **2009**, *8*, 763.
50. M. Ibrahim, N. Akhtar, S. Khan, H. Bahadar. Ethno-pharmacological Evaluation of Plants Resources of District Malakand, Pakistan. *Ethnobot. Res. Appl.,* **2023**, *25*, 1. https://doi.org/10.32859/era.25.47.1-15
51. S. Talukdar. Traditional herbal healing practices for the treatment of Malaria and associated symptoms by Miju-Mishmi tribe of Lohit district, Arunachal Pradesh, Northeast India. *Research Square* **2020**. https://doi.org/10.21203/rs.3.rs-56067/v1
52. P. Rani, N. Sood. Traditional Practice of Euphorbiaceae Growing in Rural Pockets of Sub- District Medicinal Plants of Uklana Mandi (Hisar), Haryana, India. *J. Agric.* **2021**, *4*, 1.
53. A. B. Sehgal, S. K. Sood. Ethnoveterinary Practices for Herbal Cure of Livestock Used by Rural Populace of Hamirpur, (H.P.), India. *IOSR J. Agri. Veter. Sci.* **2013**, *3*, 7. https://doi.org/10.9790/2380-0310714
54. D. K. Pal, B. Dutt, R. Dhiman, V. Attri. Economic utility of different plant species occurring in mid Himalayan region of Himachal Pradesh. *The Pharma Innovation Journal* **2020**, *9*, 176.
55. N. S. Thakur, S. K. Attar, H. T. Hegde, J. B. Bhusara. Diversity and Importance of Shrubs in Traditional Agroforestry Systems in India. In: S. K. Gupta, P. Panwar and R. Kaushal (Eds), Agroforestry for increased production and livelihood security in India. New India Publishing Agency New Delhi, India. pp. 379-400.
56. S. Verma, N. S. Chauhan. Indigenous medicinal plant knowledge of Kunihar forest division, district Solan. *Ind. J. Trad. Know.* **2007**, *6*, 494.
57. M. A. Lone. Traditonal plant remedies from Bungus valley of district Kupwara Kasmir. *IJISRT,* **2018**, *3*, 120.
58. T. A. Tariq, M. A. Tantry. Preliminary Studies on Plants with Anthelmintic Properties in Kashmir - The North-West Temperate Himalayan Region of India. *Chin. Med.* **2012**, *3*, 106. https://doi.org/10.4236/cm.2012.32017

59. A. Dutta, Y. P. Sharma, B. Singh, R. W. Bussmann. Plant-based veterinary practices in Jammu and Kashmir: A review of the trends, transfer and conservation of traditional ethnoveterinary knowledge. *Ethnobot. Res. Appl.,* **2022**, *24*, 1. https://doi.org/10.32859/era.24.4.1-24
60. J. S. Jamwal, S. Kant. Ethno-Veterinary Herbal Practice in Kalakote Range, Rajouri (J&K), India. *Nature Env Poll. Tech.,* **2008**, *7*, 571.
61. P. K. Rai, H. Lalramnghinglova. Ethnomedicinal plants from agroforestry systems and home gardens of Mizoram, North East India. *Herba Polonica.,* **2010**, *56*, 1.
62. A. Mishra, S. Parida. Latex of plants: Wonders of nature for its therapeutic potentials and a valuable resource towards new drug development. *Intern. J. Botany Studies.,* **2020**, *5*, 334.
63. M. Tailang. Ethnomedicinal plants used by some Indian tribes. *World J. Pharm. Res.,* **2014**, *4*, 549.
64. R. Ballabha, J. K. Tiwari, P. Tiwari. Medicinal Plant Diversity in Dhundsir Gad Watershed of Garhwal Himalaya, Uttarakhand, India. Journal of Ethnobiology and Traditional Medicine, **2013**, *119*, 424.
65. D. P. Semwal, P. P. Saradhi, C. P. Kala, B. S. Sajwan. Medicinal plants used by local vaidyas in Ukimath block, Uttrakhand. *Indian J. Tradit. Knowl.*, **2009**, *9*, 480.
66. H. Tiwari, M. L. Upadhyaya. Ethnomedicinal plants used for dental health care in Almora district, Uttarakhand. *J. Med. Plants Stud.*, **2020**, *8*, 117.
67. S. Moktan, P. Rai. Ethnobotanical approach against respiratory related diseases and disorders in Darjeeling region of Eastern Himalaya. *NeBIO*, **2019**, *10*, 99.
68. S. Bani, D. Chand, K. A. Suri, O. P. Suri, O. P. Sharma. Antiinflammatory Effects of an Ethyl Acetate Extract of *Euphorbia royleana*. *Phytother. Res.*1996, 10, 285-291. https://doi.org/10.1002/(SICI)1099-1573(199606)10:4%3C285::AID-PTR761%3E3.0.CO;2-P
69. S. Bani, K. A. Suri, O. P. Suri, O. P. Sharma. Analgesic and Antipyretic Properties of *Euphorbia royleana* Latex. *Phytother. Res.,* **1997**, *11*, 597. https://doi.org/10.1002/(SICI)1099-1573(199712)11:8%3C597::AID-PTR159%3E3.0.CO;2-Q
70. S. S. El-Hawary, R. Mohammed, A. F. Tawfike, N. M. Lithy, S. F. AbouZid, M. N. Amin, U. R. Abdelmohsen, E. Amin. Cytotoxic Activity and Metabolic Profiling of Fifteen *Euphorbia* Species. *Metabolites.* **2021**, *11*, 15. https://doi.org/10.3390/metabo11010015
71. A. Ashraf, R. A. Sarfraz, M. A. Rashid, M. Shahid. Antioxidant, antimicrobial, antitumor, cytotoxic activities of an important medicinal plant (*Euphorbia royleana*) from Pakistan. *J. Food Drug Anal.* **2015**, *23*, 109. https://doi.org/10.1016/j.jfda.2014.05.007
72. R. Sivaraj, A. Balakrishnan, M. Thenmozhi, R. Venckatesh. Antimicrobial activity of Aegle marmelos, Ruta graveolens, Opuntia dellini, *Euphorbia royleana* and *Euphorbia antiquorum*. *J. Pharm. Res.,* **2011**, *4*, 1507.
73. A. E. M, Soliman, S. S. Soliman. *In-vitro* Antioxidant and Cytotoxic Evaluation of *Euphorbia royleana* Ethanol Lyophilized Latex towards Hepatic Cancer Cell Line. *Chem. Res. J.,* **2022**, *7*, 43.
74. A. M. Rizk, F. M. Hammouda, M. M. El-Missiry, H. M. Radwan, F. J. Evans. Macrocyclic diterpene esters from *Euphorbia royleana*. *Phytochem.,* **1984**, *23*, 2377. https://doi.org/10.1016/S0031-9422(00)80559-2
75. M. Zafar, A. Sharif, D. Khan, B. Akhtar, F. Muhammad, M. F. Akhtar, T. Fatima. Preventive effect of *Euphorbia royleana* Boiss on diabetes induced by streptozotocin via modulating oxidative stress and deoxyribonucleic acid damage. *Toxin Reviews.* **2021**, *40*, 777. https://doi.org/10.1080/15569543.2020.1780262
76. H. A. Begum, S. M. Ali, W. Khan, T. Yassen, D. A. Jones, K. Ali. Effects of Stem Extract of *Euphorbia royleana* Boiss on Seed Germination of brassica campestris L., Trifolium repens L. and Trigonella foenum-graecum L. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.,* **2022**. *92*, 589. https://doi.org/10.1007/s40011-021-01341-z
77. Y. Y. Huang, C. H. Chen, C. H. Hsu, T. Y. Kuo, C. C. Liu, A. T. Liao, C. S. Lin. Inhibiting autophagy potentiates the antitumor efficacy of *Euphorbia royleana* for canine mammary gland tumors. *BMC Veter. Res.,* **2020**, *16*, 193. https://doi.org/10.1186/s12917-020-02408-1
78. X. -L. Li, Y. Li, S. -F. Wang, Y. -L. Zhao, K. -C. Liu, X. -M. Wang, Y. -P. Yang. Ingol and ingenol diterpenes from the aerial parts of *Euphorbia royleana* and their antiangiogenic activities. *J. Nat. Prod.,* **2009**, *72*, 1001. https://doi.org/10.1021/np800816n
79. W. –X. Liu, Y. –J. Zhang, M. Zhou, P. Zhao. New ingol diterpenoids from the aerial parts of *Euphorbia royleana* Boiss. *Phytochem. Lett.* **2021**, *46*, 66. https://doi.org/10.1016/j.phytol.2021.09.006
80. S. Wu, L. Gan, T. Su, X. Wei, S. Yin. New ingenane and ingol diterpenoids from *Euphorbia royleana*. *Nat. Prod. Res*., **2023**, *37*, 1130. https://doi.org/10.1080/14786419.2021.1993215
81. G. C. Sood, B. K. Sofat, R. D. Chandel. Injury to the eye by the sap of *Euphorbia royleana*. *Brit. J. Ophthal*., **1971**, *55*, 856. https://doi.org/10.1136/bjo.55.12.856
82. D.K. Singh, R. A. Agarwal. Alteration in biogenic amine levels in the snail lymnaea acuminata by the latex of *Euphorbia royleana*. *Toxicol. Lett*., **1984**, *21*, 309. https://doi.org/10.1016/0378-4274(84)90089-4
83. P. Singh, A. Singh. Evaluation of Latex Extract of *Euphorbia royleana* for its Piscicidal and Muricidal Activities. *World J. Agr. Sci.,* **2012**, *8*, 520.
84. T. Wangpan, J. Tasar, T. Taka, J. Giba, P. Tesia, S. Tangjang. Traditional use of plants as medicine and poison by Tagin and Galo Tribe of Arunachal Pradesh. *J. App. Pharm. Sci.,* **2019**, *9*, 98. https://doi.org/10.7324/JAPS.2019.90914
85. W. -X. Liu, M. Zhang, Y. J. Zhang, P. Zhao. Two new triterpenoids from the stems of *Euphorbia royleana*. *Nat. Prod. Res*., **2025**, *39*, 2463. https://doi.org/10.1080/14786419.2023.2300048
86. H. A. Begum, S. Yaseen, A. Zada, M. Musa, A. Khan, Sheheryar, A. F. Alrefaei, M. Almutairi, S. Ali, R. Azmat, M. Hamayun, Biological and Photocatalytic Activities of Silver Nanoparticles Synthesized from the Leaf Extract of *Euphorbia royleana* Boiss. *Curr. Pharm. Des.,* **2024**, *30*, 2813. https://edgccjournal.org/1381-6128/article/view/645949