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Potentilla fulgens: A Systematic Review on Traditional Uses, Pharmacology and Phytochemical Study with Reference to Anticancer Activity

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ABSTRACT

Potentilla fulgens has been extensively used in folk medicine by the local people of Meghalaya in North East India. Traditionally, the root-stock and the whole plant, *Potentilla fulgens* are utilized as astringent and tonic for curing the gums from tooth ailments. The aqueous root peel extract of this plant is consumed to get rid of intestinal infections and also the tap root is traditionally chewed along with betel nut (*Areca catechu*) and betel leaves (*Piper betel)* for various ailments. North East India has maximum incidence and occurrence of different types of oral cancer due to consumption of tobacco, tobacco related compounds and alcohol. Taking into consideration its high medicinal value and popularity of the plant, we have tried to compile and update the latest research work carried out by other workers and to explore its potential as anticancer therapy with a futuristic approach. Subsequently, the plant has been studied in detail on its various pharmacological activity by few researchers and two reviews were already published in the years 2009 and 2011, encompassing its pharmacological, taxonomical, phytochemical attributes. So, our aim was to explore the latest work done so far post 2011.

1. Introduction

Potentilla fulgens L (Family: Rosaceae) is a local medicinal plant, found in Northeast India, of the state Meghalaya. More than 6,500 species of medicinal plants are found in Northeast India. Scientific interest in the genus Potentilla and their curative properties originated from the realm of traditional medicine.They are known as cinquefoils in English, Bajradanti in Hindi [1], Ganeful and Dentamanjari in Nepali [2], Akanada and Dentamanjari in Uttarakhand, San geZil pa in Tibetan [1, 2] and lyniangbru (Khasi) in Meghalaya [2]. The roots of *Potentilla fulgens* are used for the treatment of colic pain, spasmodic trouble, pyorrhea and tumor [3]. Ethnic groups of this region use leaves, bark, roots, shoot etc of *Potentilla fulgens* as a source of medicine [4]. The aqueous root peel extract of *P. fulgens* is consumed to get rid of intestinal parasitic infections. *P. fulgens* contains rich amount of polyphenols in stem, leaves and root, as a result, it is widely used for medicine in the Ayurvedic, Unani and Siddha systems of medicine in India [5, 6]**.** North-east India is one of the 25 global biodiversity hotspots which lies between 22-30° N latitude and 89-97° E longitude where the region is endowed with varied flora to its diversified topography and climatic conditions with high rainfall, moderate temperature and high humidity abound with dense forests, marshes, swamps etc., [3]. Different tribes living in this area mostly dependent on traditional herbal medicine for their primary health care services as herbal medicines are less toxic and have no side effects in comparison to the chemotherapeutic drugs also cheaper as preferring chemotherapeutic drugs is not always affordable for this people. So, the cheap herbal drug treatment may highly be recommended to the rural and poor people to treat effectively the cancers of various types is an ideal choice. More than 50% of all modern drugs in clinical use are of natural product origin, so keeping in mind the importance of herbal medicinal plants a thorough literature based search was primarily done to write this review on *Potentilla fulgens* as it is extensively found in North-east part of India.

In order to gather information the keywords "(*Potentilla fulgens* or *Potentilla* or *P. fulgens*) and (traditional or therapeutic or medicinal or pharmacological uses)", "(cancer or anticancer or carcinogenic or anti-tumor activity and *Potentilla fulgens* or *Potentilla* or *P. fulgens*)" were searched in databases such as Pubmed, ScienceDirect, Scopus, Google Scholar, a total of 55 articles were found, some nonrelevant articles were excluded and among them only two papers were found as review article [7, 8]on *Potentilla fulgens* and Potentilla species which were published in 2009 and 2011 respectively covered detail and elaborate information on pharmacological activity and phytochemical constituents. This review includes research work done post 2011 so that further studies and research work can be extended in new direction.

2. Scientific Classification of *Potentilla fulgens*

Kingdom : Plantae
Order : Rosales
Family : Rosaceae
Genus : *Potentilla*
Species : *P. fulgens*

3. Habitat

It grows in rocky terrains. They thrive in heavy soils. Propagation is done through seed, cuttings or division of rootstocks. It grows in regions with a temperate climate and at a high elevation of about 1800 – 4350 metres above sea level.

Fig. 1 *Potentilla fulgens* Wall. ex Hook. plant [a] and root [b]

4. Morphology

Typical cinquefoils looks most similar to strawberries. They have palmate leaves. They have fifteen or more leaflets arranged pinnately. The flowers are generally yellow in colour and flowering stems are 5-40 cm tall (Figs. 1 and 2). The accessory fruits are usually dry, but may be fleshy and strawberry-like, while the actual seeds – each one technically a single fruit – are tiny nuts. The plant have thick rootstock, erect perennial herb (15-75) cm and thrives well in moist places.

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Fig. 2 Image of herbarium specimen at Royal Botanic Garden Edinburgh (E). Specimen barcode number E00012791. Specimen collected from: India

5. Growth

Potentilla fulgens grows in open meadows and grassy slopes in the Himalayas. It gives leaves by May and flowers by June-July and starts to fruit by August and deteriorates by September. It reproduces from both the seeds and roots [9].

6. Taxonomy

Among the Rosaceae, cinquefoils are close relatives of avens (genus Geum) and roses (Rosa), and even closer relatives of agrimonies (Agrimonia). Lady's mantles (Alchemilla) and strawberries (Fragaria) are more closely related to Potentilla (Wipikedia).

7. Distribution

Potentilla fulgens which is commonly known as the Himalayan Cinquefoil and *Lyngniangbru* by the Khasi tribe of Meghalaya is widely found in North-east India as well as in Northern parts of India. It is found in the wild habitats of Meghalaya. Globally different species of Potentilla are found in Asia, Europe and North America, where as species diversity is found highest in Northern Eurasia.

Fig. 3 Distribution in India

Fig. 4 Global distribution areas of Potentilla species

8. Utility and Edibility

The root stock as well as whole *Potentilla fulgens* are utilized for ethnological purposes. Fresh tap roots are pulverized, weighed and soaked in methanol to make the methanol extract which is used for biological activity [10]. The root is chewed with betel nut in North eastern part of India which is effective against high blood pressure, is safe to use as a homemade remedy [11]. Leaves, bark, root and shoots are the edible parts of *Potentilla fulgens* and commercially used by the local people for treatment of diseases.

9. Traditional and Medicinal Uses of *P. fulgens*

The aqueous root peel extract of this plant is consumed to get rid of intestinal parasitic infections). The root has anti-diarrheal properties and are effective against high blood pressure and is safe to use as a homemade remedy. Traditionally in Northeast India, the root-stock and the whole *Potentilla fulgens* is utilized as astringent and tonic for curing the gums from tooth ailments such as pyorrhea, toothache and caries and other tooth ache. Twigs and leaves of *Potentilla fulgens* are mostly used as toothbrush by the Bhutias in Uttarakhand in India. Leaf paste is used for curing stomach pain, cough, cold, throat soar and ulcer [10]. Roots are also used for treatment of wounds and tiger bites in Garhwal district of Himalayan region. Whole plant is used for stomatitis and aphthae. In countries like Nepal and Bhutan, plant juice is taken for treatment of peptic ulcer and disusia [12].

Syiem et al., had done extensive work on *Potentilla fulgens* and reported that it can also prevent cell death and exhibit anti carcinogenic activity [11]. *Potentilla fulgens* Wall. ex Hook. falls among ethnoveterinary plants as well which is used to regulate the fertility in female cattle by giving whole plant decoction once daily for fifteen days [16].

10. Pharmacological Activities

Pharmacological studies report that *Potentilla fulgens* possesses antioxidant (*in vitro* models), antitumor, hypoglycaemic and anti-hyperglycemic activities [13-15], antioxidant, anti-inflammatory, antiulcerogenic properties.

10.1 Anticariogenic Activity

Initially, *Potentilla fulgens* is used by tribal people of North-east India to cure teeth and gum problems. Crude methanol extract was found to have good anticariogenic potential. *Epigallocatechin gallate* was the most effective inhibitor against tested bacterial strains [16]. From Time-kill studies and biofilm formation inhibition assays, catechin (4α→8) epicatechin and Potentilla extracts could be employed as natural antibacterial agents in oral health care products [17].

10.2 Anticancer Activity

Its anti-cancer property was reported by Rosangkima (2010) in which preliminary investigation on some anticancer medicinal plants for cancer therapy conducted in murine ascites Dalton's lymphoma model. Among them ethanol extract of *D. pentagyna* showed the most potent antitumor activity, i.e. % ILS ~ 55% and % ILS ~ 48% at a dose of 50 and 100 mg/kg/day, respectively; followed by aqueous extract of *P. fulgens* showing % ILS ~ 37% at a dose of 50 mg/kg/day. Out of different fraction extracts of *D. pentagyna* and *P. fulgens* , better antitumor activity was observed with chloroform extract of *D. pentagyna* (% ILS ~ 89%) and hexane fraction of *P. fulgens* (% ILS ~ 37%) at a dose of 50 mg/kg/day, which is due to the presence of alkaloids and flavonoids.

Indian authors determined the effectiveness in antitumor activity among kaempferol (KMP) as flavonoids, ellagic acid (ELA) as polyphenols and methanolic extract of the root of *P. fulgens* (PRE) in Ehrlich ascites tumour (EA) and MCF-7 cancer cells. Phenolic and flavonoid content were 138.8 ± 1.6 mg gallic acid and 401.6 ± 4.6 mg quercetin per g of the extract, respectively. The extract showed increase *in vivo* survivability of mice bearing EA cells and loss of cell viability in a dose-dependent manner in MCF-7 cells. Endogenous level of glutathione was depleted significantly in MCF-7 cells after the treatment with PRE only but not with KMP or ELA. Induction of apoptotic cell death and lowering the level of glutathione are highly desirable mode for an anticancer agent. Preliminary investigation on the anti-tumor activity of the methanolic extract of the root of *P. fulgens* was found to be active in a dose dependent manner [18].

Methanolic (MeOH), butanolic (BuOH) and dichloromethane-MeOH extracts of *P. fulgens* L. roots showed *in-vitro* cytotoxic activity against various human cancer cell lines viz. Leukemia (THP-1), liver (HEP-2), ovary (OVCAR-5) , lung (A-549), prostrate (PC-3) and neuroblastoma (SF-295). MeOH extract was found to be most potent and BuOH extract the

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least cytotoxic activity. DCM-MeOH extract showed significant activity against A-549 cancer cell line, whereas BuOH extract showed no cytotoxic effect with the other cancer cell lines used for the study. Cytotoxic effects was shown by MeOH extract at higher concentration (50 µg/mL & 100 µg/mL) against OVCAR-5, A-549, PC-3 and SF-295 cancer cell lines while DCM-MeOH extract at 100 µg/mL exhibited significant cytotoxic effect against HEP-2 cancer cell line.

Table 1 Percentage growth inhibition induced by polar extracts of *P. fulgens* in six human cancer cell lines at 10, 50 and 100 µg/mL. Values are reported as mean ±SEM. Experiments are carried out in triplicates. The known anti-cancer drugs, 5-flurouracil and mitomycin-C were used as positive control

Cell Line Type →		THP-1	HEP-2	OVCAR-5	A-549	PC-3	SF-295
Tissue Type →		Leukemia	Liver	Ovary	Lung	Prostrate	CNS
Extract ↓	Conc. µg/mL	% Growth Inhibition					
Methanol (MeOH)	10	0 ± 3	30 ± 3	0 ± 3	0 ± 3	2 ± 3	0 ± 2
	50	0 ± 2	33 ± 2	4 ± 3	12 ± 2	1 ± 3	3 ± 2
	100	0 ± 3	63 ± 3	15 ± 2	24 ± 3	12 ± 1	11 ± 1
Butanol (BuOH)	10	0 ± 2	0 ± 2	0 ± 2	1 ± 2	1 ± 1	6 ± 1
	50	0 ± 2	5 ± 1	0 ± 2	1 ± 1	1 ± 2	0 ± 3
	100	0 ± 2	16 ± 3	0 ± 1	7 ± 3	1 ± 3	0 ± 3
Dichloromethane: methanol (1:1) (DCM-MEOH	10	1 ± 1	0 ± 1	0 ± 1	5 ± 1	1 ± 3	2 ± 2
	50	0 ± 1	8 ± 2	0 ± 2	29 ± 3	1 ± 2	2 ± 1
	100	0 ± 3	21 ± 1	10 ± 2	33 ± 2	1 ± 1	2 ± 3
Standard compounds:							
5-fluorouracil	20 µM	86 ± 3	-	75 ± 3	85 ± 1	77 ± 1	86 ± 1
Mitomycin-C	1 µM	-	85 ± 3	-	-	-	-

Extracts of two endophytic fungal isolates belonging to *Aspergillus niger* namely PFR1 and PFR6 were isolated from the roots of *Potentilla fulgens* L. to evaluate anti-cancer properties in two breast cancer cell lines MCF7 (ER+) and MDA MB 231 (ER-), cervical cancer cell line HeLa and epidermal oral cancer cell line KB. Through MTT and colony formation assay, cytotoxic effects were evaluated. PFR6 showed better cytotoxic effect than PFR1. Nuclear degradation of cells examined and prominent morphological alterations were observed.

10.3 Treatment of Eye-Disorder

Huseyin *et al,* [19] in the paper "Effects of *Potentilla fulgens* on the Changes Made in the Retinal Damage Induced by Traumatic Head Injury", Sprague-Dawley rats were subjected to traumatic brain injury with a weight drop device using 300 g-1 m weight-height impact. Twenty one rats were taken and divided into three groups which are indicated as group1 (vehicle-treated control), group2 (vehicle-treated trauma) group 3 trauma + *Potentilla fulgens* 400 mg/kg/day, i.p). All rats were decapitated 5 days after the induction of trauma and protective effects of *Potentilla fulgens* were evaluated by histological, immunohistochemical and biochemical analyses. Whether trauma inhibits apoptosis of photoreceptor cells, ganglion cells, it is thought that the support against the degeneration of neural connections can be considered. The study indicates that *P. fulgens* is potentially useful for the treatment of eye disorders induced by traumatic brain injury.

10.4 As a Prophylactic Agent

In another study [20], the protective effects of *Potentilla fulgens* extract on damage of testicular tissue created by ischemia and reperfusion treatment via histpathological immunohistochemical, and TUNEL experiments was carried out. In this study, 24 Sprague-Dawley male rats were taken and divided into four subgroups control group, torsion group, torsion-detorsion group, *Potentilla fulgens* + torsion-detorsion group. Extract of *P.fulgens* was injected into the rats, 400mg/kg for five days. Right testicle was exposed to torsion and detorsion for 2 hours with a 720° turn. The rats were anesthetized with ketamine hydroxide and then the right testicle was dissected from the scrotum. Fixation with 10% formaldehyde solution, was done. Immunohistochemically slides were stained with TNF-α antibody and using the TUNEL protocol apoptotic changes were examined. Degeneration and disorganization of the spermatic cells and changes in tubule diameter were found to be statistically significant from histopathologic examination. Using the TUNEL method hispathological examination of the apoptotic indices was scored. TNF-α expression was positively observed in the ischemia and the ischemia-reperfusion groups. Due to torsion and detorsion exposure, which led to damage in spermatic cells of seminiferous tubules, *Potentilla fulgens* decreased apoptotic development and thought to be the cause of activation in spermatic cells.

10.5 Antidiabetic Activity

Indian author, D. Syiem [21] investigated the effective dose of methanolic extract of *Potentilla fulgens* on Aldose Reductase activities in liver, kidney and eye tissues of normal mice using intraperitoneal (i.p) and oral routes. Polyol metabolozing pathway comprised of two enzymes aldose reductase (AR) and sorbitol dehydrogenase (SDH), which convert glucose to fructose. The pathway is accelerated by elevated cytoplasmic glucose concentrations induced by hyperglycemia. Swiss albino mice were divided into two groups. The control group was given 2% ethanol and the treated groups were given (50-350 mg/kg body weight) of the extract through i.p and oral route. After four weeks, animals were sacrificed by cervical dislocation and dissected carefully to remove the liver, kidney and the eye balls of individual group to analyse the activities in Alloxan-induced diabetic mice shows significant increase in AR activities from normal mice. In liver tissue, AR activity was increased by 63% ($p<0.01$), in kidney by 67% ($p<0.001$) and in eye tissue by 58% ($p<0.01$) as compared to normal mice. At the dose of 250mg/kg via i.p route to the diabetic mice results in AR inhibition, the magnitude varied in a tissue specific manner. The same group also reported tissue specific inhibition of SDH by methanolic extract of *Potentilla fulgens* L in normal and diabetic mice.

One more study was done by the same authors, to identify the active fraction of *P. fulgens* with aldose reductase inhibitory potential. Kidney homogenates of normoglycemic and diabetic mice were used as a source of AR enzyme preparation for *in vitro* analysis. IC_{50} value (0.152 mg/mL) shows the lowest for Terpenoid/Phenolic (TP) fraction of *P.fulgens*. Using thin layer chromatography, TP fraction was separated and separated TLC fractions were tested for AR inhibitory activity. F-V had the lowest IC_{50} value (0.156 mg/mL). Biochemical analysis confirms that the TP fraction contained polyphenolic and flavonoid group which is separated into different fractions by TLC where fraction F-V was found to have better inhibitory activity against AR compared to other TLC fractions.

10.6 Gastroprotective Activity

Gastroprotective activity of ethanolic root extract (EPF), was evaluated on four gastric-ulcer models such as pyloric ligation (PL), ethanol (EtOH), cold restrain stress (CRS) and aspirin (ASP)-induced gastric ulcers. EPF (200–400 mg/kg, p.o.) showed significant protection against acute gastric-ulcer induced by EtOH, PL and CRS (400 mg/kg, p.o.), but was found to be ineffective against ASP-induced ulcerogens [22]. Alcoholic root extract of *Potentilla fulgens* (APF) on various gastric ulcer models showed that treatment with APF significantly increased the gastric juice PH, decrease the gastric volume and total acid-pepsin output and significantly reduced the gastric juice cell shedding.

11. Phytochemical Constituents

Potentilla fulgens is rich in polyphenolic and triterpene constituents [23-26]. From the root parts of *P. fulgens* phytochemical investigation led to the isolation of a novel bioflavonoid potifulgene (Epiafzelchin-6-o-8´´ epiafzelchin) along with epicatechin [25]. Two new ursane type triterpenoids, Fulgic acid A [27] and Fulgic acid B were identified and characterized [28].

Choudhary *et al,* [29] had undertaken extensive studies to evaluate the anticariogenic effects of the plant and search for potent anticariogenic phenolic molecules. Polyphenolic compounds-1. Afzelechin 2. Epiafzelechin 3. Epigallocetechin 4.Epigallocetechin gallate 5. Epicatechin 6. Catechin 7. Aafzelechin(4β→8)epicatechin 8. Epiafzelechin (4β→8) epicatechin 9.Catechin (4α→8) epicatechin 10. Afzelechin(4α→8)catechin and 11.Afzelechin (4α→8) epiafzelechin [29] were isolated from the roots of *Potentilla fulgens* using semi-preparative HPLC. The structure of the chemical compounds are given below.

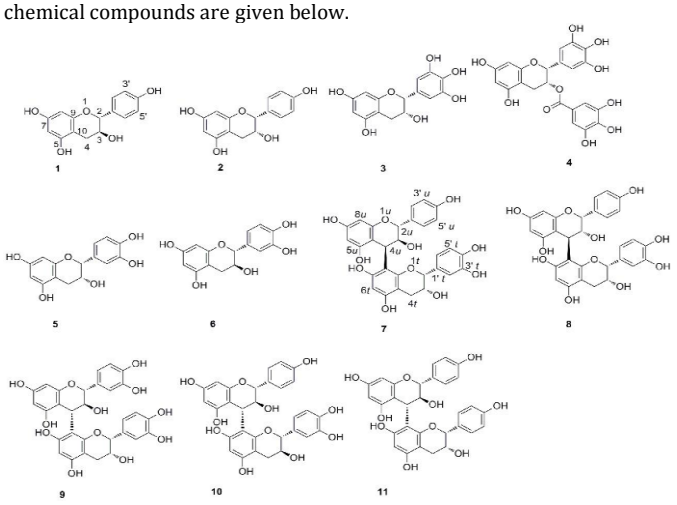

Fig. 5 Chemical constituents isolated from ethyl-acetate extract of *Potentilla fulgens*- 1. Afzelechin 2. Epiafzelechin 3. Epigallocetechin 4.Epigallocetechin gallate 5. Epicatechin 6.Catechin 7. Aafzelechin(4β→8)epicatechin 8. Epiafzelechin (4β→8) epicatechin 9.Catechin (4α→8) epicatechin 10. Afzelechin(4α→8)catechin and 11.Afzelechin (4α→8) epiafzelechin [29].

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From time kill study, adherence study and morphological studies, compounds epigallocetechin, epigallocetechin gallate and epiafzelechin (4β→8) epicatechin were found to exhibit better cariogenic profile than other compounds. Epiafzelechin (4β→8) epicatechin was found to possess comparable anticariogenic effects as of epigallocetechin gallate which suggests that *Potentilla fulgens* can be considered as a source of anticariogenic agents [14] identified various chemical markers in the extracts of *P. fulgens* roots using NMR, MALDI/TOF/MS, ESI/MS/MS and HPLC/UV. Fourteen marker compounds were detected in the crude methanol extract of *P. fulgens* by HPLC/UV methods at different wavelengths.

Table 2 Quantization of isolated compounds in methanol extract and roots of *P. fulgens*

Number	Compound	Content (%)[a] Methanol extract	Content (%)[a] in roots
1	Catechin	1.6 ± 0.03	0.40 ± 0.06
2	Catechin (4α→8) epicatechin	2.1 ± 0.08	0.52 ± 0.08
3	Afzelechin (4α→8) catechin	1.5 ± 0.12	0.37 ± 0.01
4	Afzelechin (4β→8) epicatechin	1.3 ± 0.33	0.32 ± 0.04
5	Epicatechin	2.7 ± 0.23	0.67 ± 0.03
6	Afzelechin (4α→8) epiafzelechin	1.4 ± 0.01	0.35 ± 0.07
7	Afzelechin	1.5 ± 0.11	0.37 ± 0.01
8	Epiafzelechin	1.7 ± 0.05	0.42 ± 0.06
9	Epiafzelechin (4β→8) epicatechin	0.9 ± 0.13	0.22 ± 0.03
10	Euscaphic acid	1.2 ± 0.16	0.30 ± 0.02
11	Fulgic acid A	0.076 ± 0.01	0.019 ± 0.03
12	Fulgic acid B	0.078 ± 0.18	0.019 ± 0.01
13	Ursolic acid	3.3 ± 0.07	0.82 ± 0.05
14	Corosolic acid	0.075 ± 0.04	0.018 ± 0.01

[a]Content = mean ± SD ($n = 3$)

Ursolic acid (0.82 ± 0.05%) and epicatechin (0.67 ± 0.03%) were the major compounds in the tested sample of roots [29].

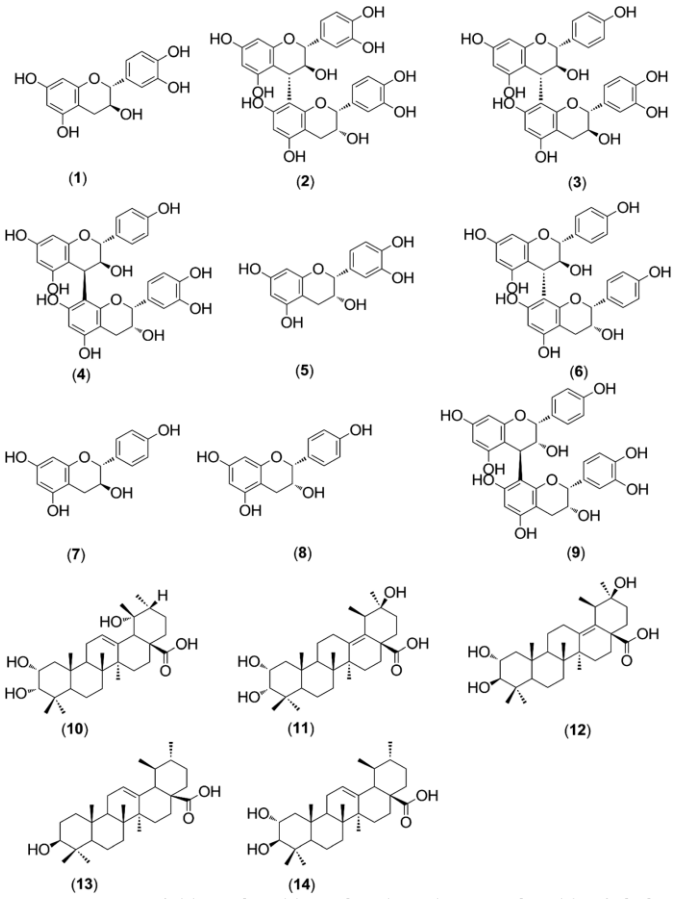

Fig. 6 Structure of (1)Catechin (2)Catechin (4α→8) epicatechin (3) Afzelechin (4α→8) catechin (4) Afzelechin (4β→8) epicatechin (5) Epicatechin (6) Afzelechin (4α→8) epiafzelechin (7) Afzelechin (8) Epiafzelechin (9) Epiafzelechin (4β→8) epicatechin (10) Euscaphic acid (11) Fulgic acid A (12) Fulgic acid B (13) Ursolic acid (14) Corosolic acid quantified using HPLC/UV

In another study [30], from ethyl acetate extract of *P. fulgens* compounds, 2α,3α,20β-trihydroxyrus-13-en-28-oic acid, 2α,3β,20β-trihydroxyurs-13en-28-oic, p-hydroxy benzaldehyde, gallic acid were isolated which exhibited good antioxidant activity.

Phenolic compounds, quercetin, ellagic acid and kaempferol were reported for the first time in n-butanol fraction of *P. fulgens* , acts as potential antioxidative and cancer chemopreventive agents [31].

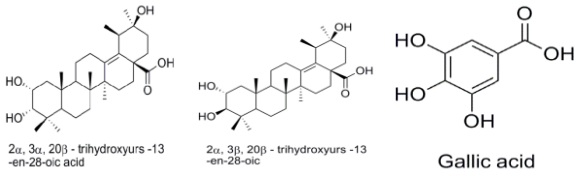

Fig. 7 Structure of compounds 2α,3α,20β-trihydroxyrus-13-en-28-oic acid, 2α, 3α,20β-trihydroxyrus-13-en-28-oic and gallic acid [30]

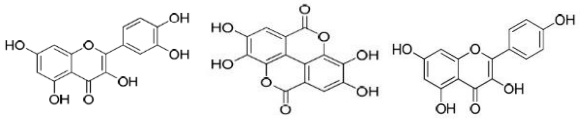

Fig. 8 The structures of compounds quercetin, ellagic acid, kaempferol isolated from *P. fulgens L.*

12. Cancer

In pathology, cancer is termed as a malignant and invasive growth or tumor, especially originating in epithelium, tending to recur after excision and to metastasize to other sites. A majority of cancers are caused by changes in the cell's DNA because of damage due to the environment. The majority of cancers, 90–95% of cases, are due to genetic mutations from environmental factors and the remaining 5–10% is due to inherited genetics [32]. Cancer has a unique combination of genetic changes. Additional changes occur as the cancer continues to grow. Even within the same tumor, different cells may have different genetic changes. The genetic changes that contribute to cancer tend to affect three main types of genes—proto-oncogenes, tumor suppressor genes, and DNA repair genes. These changes are called "drivers" of cancer (NIH, National Cancer Institute, 1937. Drivers of Cancer. Common cancer types – cancer of Bladder, Breast Cancer, Colorectal Cancer, Kidney (Renal Cell) Cancer, Leukemia, Liver Cancer, Lung Cancer, Lymphoma, Pancreatic Cancer, Prostate Cancer, Skin Cancer, Thyroid Cancer, Uterine Cancer.

13. Ayurvedic Concept of Cancer

Charaka and Sushruta Samhita both described the equivalent of cancer as "*granthi*" and "*arbuda*"[33]. Based on the *doshas* involved "*Granthi"*and "Arbuda" can be inflammatory or devoid of inflammation [34]. According to the Ayurvedic definition of health, three *doshas* "*Vata, Pitta and Kapha"* in body are responsible for disease and the balanced coordination of these *doshas* in body, mind and consciousness [35]. *Tridoshicarbudas* are usually malignant because all three major body humors lose mutual coordination, resulting in a morbid condition [36]. In Ayurveda, neoplasm can be classified which depends upon various clinical symptoms in relation to *tridoshas*.

Group I: Diseases that can be named as clear malignancies, including *arbuda* and *granthi*, such as *mamsarbuda* (sarcomas) and *raktarbuda* (leukaemia), *mukharbuda* (oral cancer), and *Asadhya vrana* (incurable or malignant ulcers). Group II: Diseases that are not cancers but can be considered probable malignancies, such as ulcers and growths. Examples of these are *Mamsaja oshtharoga* (growth of lips), *Asadhya galganda* (incurable thyroid tumour), *Tridosaja gulmas*, and *Asadhya udara roga*, (abdominal tumours like carcinomas of the stomach and liver or lymphomas). Group III: Diseases in which there is a possibility of malignancy, such as *visarpa*, *Asadhya kamala* (incurable jaundice), *Asadhya pradara* (intreatable sinusitis) [37].

14. Aim of Cancer Therapy and Cancer Causing Genes

The primary aim of cancer therapy is to act at cellular level which includes (i)inhibiting cancer cells proliferation,(ii)promoting apoptosis of cancer cells, (iii) enforcing the necrosis of tumour and (iv)blocking its metastasis. The secondary aim is to (i) maintain the haemopoietic functions to remain normal and (ii) to promote the reverse transformation from tumour cells to normal cells. There are four main types of gene involved in cell division. Most tumours have faulty copies of more than one of the genes viz., (i) Oncogenes- Ontogenesis were the genes, under normal circumstances starts dividing. When oncogenes are activated they speed up cell's growth rate. When one of the cell becomes damaged, causing cancer, it is like the accelerator is becoming stuck down-the cell, and all its daughter cells, are permanently instructed to divide. (ii) Tumor suppressor genes-This genes make proteins whose normal function is the opposite to that of ontogenesis. P-53is one of the most important tumor suppressor genes.(iii) DNA repair genes- these are the genes that ensure each strand of genetic information is accurately copied during cell division of the cell cycle. Mutations in DNA repair genes lead to an increase in the

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frequency of mutations in other genes such as protooncogenes and tumor suppressor genes. Cells contain many different proteins whose job is to repair the damaged DNA but if the DNA damage occurs to a gene that makes a DNA repair protein, a cell's ability to repair itself will be reduced, and that can allow errors to accumulate in other genes over time.

15. Cancer- a looming threat and its current status in North East India

North-East region of India has different food habits, customs, life-style, diverse ethnic groups and type and pattern of tobacco use in as compared to the rest of the country. The carcinogenicity of tobacco is attributed to nitrosamines, PAHs, benzene, Benzo(a)pyrene etc. There is extensive use of pesticides in tea gardens in North-East which can lead to widespread occupational and environmental exposures.

ICMR's National Centre for Disease and Informatics Research released the most recent cancer rates for India, based on data from 27 population-based cancer registries located across the country including northeast states. The estimate predict 15 lakh new cases of cancer each year in India with breast, lung and cervical cancers topping the list. But the latest data show the highest age-adjusted cancer rates in India are in the Northeast, with Aizawl district in Mizoram for males (271 per 100,000) and Papumpare district in Arunachal Pradesh for females (249 per 100,000). East Khasi Hills ranks third at 211.5 per 100,000 for men in cancer rate in North east. For certain cancer sites, the highest rates occur in Meghalaya, such as oesophageal cancer in East Khasi Hills for both men (71.2 per 100,00) and women (33.2 per 100,000) as well as hypopharynx (22.2 per 100,00) and larynx (10.8 per 100,000) in men. Tobacco-related cancers have the highest rates in North east (eg, tongue in males; lung, mouth, nasopharynx and oesophagus in both men and women). Cancers of the liver in men and cervix in females are also the other types of cancer which are also estimated to be highest in North-east India.

Table 3 Anticancer plants (Botanical name, parts used, active compounds, origin) [38-40].

Botanical name of plant with family name	Part used	Parts used and their main active components	Origin / native place
Agave americana (Agavaceae)	Leaf	Steroidal saponin, alkaloid, coumarin, isoflavonoid, hecogenin and vitamins (A, B, C)	Central America
Agropyron repens (Poaceae)	Rhizomes	Rhizome contains essential oil, polysaccharide and mucilage	Europe
Agrimonia pilosa (Rosaceae)	Herb	Agrimonolide, flavonoid, triterpene, tannin and coumarin	China, Japan, Korea, India
Ailanthus altissima (Simaroubaceae)	Bark	Triterpene, tannin, saponin and quercetin-3-glucoside	China, Korea
Akebia quinata (Lardizabalaceae)	Fruit	Flavonoid and saponin	China, Japan, Korea
Alpinia galanga (Zingiberaceae)	Rhizomes	Kaempferide and flavone	Europe
Aristolochia contorta (Aristolochiaceae)	Root and fruit	Lysicamine and oxaporphine	China, Korea
Aster tataricus (Asteraceae)	Whole plant	Triterpene, monoterpene and epifriedelanol	Japan, Korea
Bryonia dioica	Root	Cucurbitacin and glycoside	Europe
Cannabis sativa (Cannabinaceae)	Leaf	Stereo isomers of cannabitriol	South Africa
Chelidonium jajus var. *asiaticum* (Papaveraceae)	Herb	Alkaloids (sanguinarine, chelerythrine, berberine)	Asia, Europe
Chimaphila umbellate (Ericaceae)	Whole plant	Ericolin, arbutin, urson and tannin	Asia, Europe
Coix lachryma jobi (Poaceae)	Seed	Trans-feruly stigmasterol	China
Dryopteris crassirhizoma (Polypodiaceae)	Rhizomes	Filicinic and filicic acids, aspidinol and aspidin	China, Japan, Korea
Echinops setifer (Asteraceae)	Whole plant	Echinopsine	Korea
Erythronium americanum (Liliaceae)	Whole plant	Alpha-methylenebutyrolactone	North America
Euonymus alatus (Celastraceae)	Whole plant	Triterpene, euolatin, steroid and sesquiterpene alkaloid	China, Japan, Korea
Eupatorium cannabinum (Asteraceae)	Whole plant	Sesquiterpene, lactone, pyrrolizidine alkaloidand flavonoid	Europe, Asia,
Fragaria vesca (Rosaceae)	Leaf and fruit	Flavonoid, tannin, borneol and ellagic acid Asia, Europe	Asia, Europe
Fritillaria thunbergii (Liliaceae)	Whole plant	Alkaloid and peimine	China, Siberia
Galium aparine (Rubiaceae)	Cleaver	Iridoid, polyphenolic acid, tannin, anthraquinoneand flavonoid	Europe , Africa
Hydrastis canadensis (Ranunculaceae)	Whole plant	Isoquinoline alkaloids (hydrastine, berberine, berberastine, candaline), resin and lactone	Canada, United States
Junchus effuses (Juncaceae)	Whole plant	tridecanone, effusol, juncanol, phenylpropanoid and a-tocopherol	China, Japan, Korea
Lantana camara (Verbenaceae)	Whole plant	Alkaloids (camerine, isocamerine, micranine,lantanine, lantadene)	Tropical America
Larrea tridentate (Zygophyllaceae)	Whole plant	Resin	Southwestern USA,Mexico
Lonicera japonica (Caprifoliaceae)	Whole plant	Tannins, saponins and carotenoids	China
Olea europrae (Oleaceae)	Leaf and oil	Oleic acid and polyphenol	America
Panax quinquefolium (Araliaceae)	Roots	Ginsenoside, sesquiterpene, limonene vitamins (B_1, B_2, B_{12})	China, Japan, Korea
Phaleria macrocarpa	Fruits	Gallic acid	Indonesia
Polygonatum multiflorum (Liliaceae)	Whole plant	Saponin, flavonoid and vitamin A	Asia, Europe, North America
Potentilla chinensis (Rolsaaceae)	Whole plant	Gallic acid and tannin	China, Japan, Korea
Pygeum africanum (Boraginaceae)	Bark	Phytosterol, triterpene and tannin	Africa
Pyrus malus (Rosaceae)	Bark and fruit	Quercetin, catechin, flavonoid, coumaric and gallic acids, and procyanidin	Britain
Rhus chinensis (Anacardiaceae)	Leaf	Tannin, apigenin and glycoside; seed contains bruceosides (A, B),	China, Japan, Korea
Rubus idaeus (Rosaceae)	Leaf	Flavonoid and tannin; fruit contains vitamins (A, B, C) and ellagic acid	Asia, Europe
Scilla natalensis (Hyacinthaceae)	Bulb	Bulb	South Africa
Scrophularia nodosa (Scrophulariaceae)	Aerial parts	Iridoid, flavonoid and phenolic acid	Europe
Smilax chinensis (Liliaceae)	Rhizomes	Tannin, saponins and flavonoid	China, Japan
Tabebula spp. (Bignoniaceae)	Bark	Quinine, bioflavonoid and co-enzyme Q	South America
Thuja occidentalis (Cupressaceae)	Whole plant	Flavonoid, tannin, volatile oil and mucilage	Northeastern USA, Europe
Thymus vulgaris (Lamiaceae)	Whole plant	Volatile oil, flavonoid and tannin	South Europe
Trifolium pratense (Fabaceae)	Flower	Glucosides (trifolin, trifolitin, trifolianol), flavonoid	Asia, Europe, Africa, Australia
Vitex rotundifolia(Verbenaceae)	Whole plant	Camphene, pinene and diterpene	China, Japan, Korea

16. Epigenetics of Cancer

Development of cancer involves alterations of epigenetic processes and their deregulation [41]. In cancer cells, the control of hypermethylation of tumour-suppressor genes on CpG islands is deregulated which results in gene silencing and inactivation of tumour-suppressor genes [42].

There are many forms of cancer which share similar characteristics or genotypes such as insensitivity to signals which inhibit cell growth making their replication limitless. In cancer cells apoptosis is evaded and never induced and angiogenesis is sustained within the tumour tissue allowing survival of cancer cells [43]. In recent years development of new drugs which can inhibit or reverse epigenetic alterations are in process [41]. Some chemically derived epigenetic drugs have been developed and undergone trials such as 5-azacytidine (azacitidine; Vidaza) and 5-aza-2 ‟-deoxycytidine (decitbine; Dacogen) which are both DNMTi [44] and HDACi such as suberoyanildehydroxamic acid (SAHA, Vorinostat, Zolinza) and FK228 (Romidespin, Istodax). But, it is difficult to get a chemically derived drug which is non-toxic to normal cells and is specific to cytotoxicity of cancer cells. Therefore, research and development into naturally derived compounds to be used for anticancer treatment is becoming high in demand with a focus on those derived from plant species and their natural products.

17. Molecular Mechanisms of Cancer

Cell genotypes of cancer are a manifestation of six essential alterations in cell physiology that collectively dictate malignant growth; self-sufficiency in growth signals, insensitivity to growth-inhibitory (anti-growth) signals, evasion of programmed cell death (apoptosis), limitless replicative potential, sustained angiogenesis and tissue invasion with metastasis. Environmental as well as endogenous DNA-damaging agents and genetic instability drive tumor progression by generating mutations in two types of genes, oncogenes and tumor suppressor genes, providing cancer cells with selective growth advantage and thereby leading to the clonal outgrowth of a tumor. At first proto-oncogenes can be activated by translocations. For e.g Burkitt's Lymphoma results from translocation of the *c-myc* protooncogene from chromosomes 2,14 or 22. Secondly proto-oncogenes can be activated by point mutations. For e.g. in a large variety of malignant neoplasms it is found that point mutations of genes coding for guanosine-triphosphate binding proteins such as H-,K- or N-*ras* or G proteins can be oncogenic. Third mutations that inactivate a gene can result in tumors if the product of the gene normally constrains cellular proliferation [45].

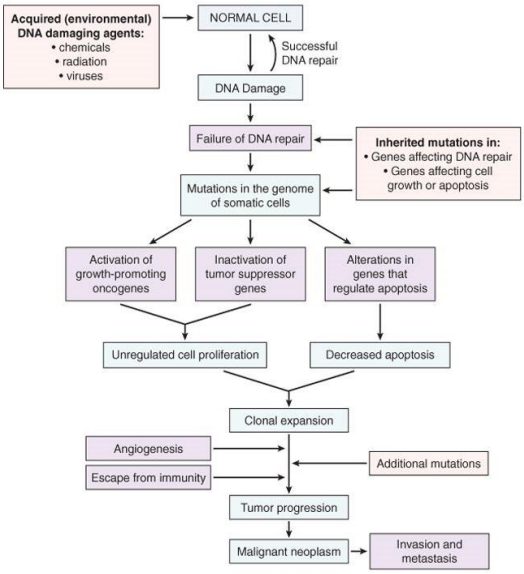

Fig. 9 Flowchart depicting a simplified scheme of the molecular basis of cancer

18. Cancer Prevention

Around 30-50% of all cancer cases are avertable. Prevention offers the most cost-effective long-term strategy for the control of cancer. The preventive measures should be taken from: Tobacco- Tobacco smoking: causes cancers of the lung, oesophagus, larynx (voice box), mouth, throat, kidney, bladder, pancreas, stomach and cervix.

Physical inactivity, dietary factors, obesity and being overweight- Dietary modification is an important approach to cancer control. There is a link between overweight and obesity to many types of cancer such as oesophagus, colorectum, breast, endometrium and kidney. Diets rich in fruits and vegetables may have an independent protective effect against many cancers. Regular physical activity, maintenance of healthy body weight, healthy diet considerably reduce cancer risk.

Alcohol use- Alcohol use is a risk factor for many cancer types including cancer of the oral cavity, pharynx, larynx, oesophagus, liver, colorectum and breast.

Infections- Approximately 15% of all cancers was attributable to infectious agents such as Helicobacter pylori, human papilloma virus (HPV), hepatitis B and C, and Epstein-Barr virus. Vaccines are available for hepatitis B virus and some types of HPV and can reduce the risk of liver and cervical cancers, respectively.

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Environmental pollution- Pollution of air, water and soil with carcinogenic chemicals contributes to the cancer burden to differing degrees depending on the geographical settings.

Occupational Carcinogens- Occupational cancers are concentrated among specific groups of the working population, for whom the risk of developing a particular form of cancer may be much higher than for the general population. Occupational carcinogens are causally related to lung cancer, mesothelioma, and bladder cancer.

Radiation- Exposure to all types of ionizing radiation, from both natural and man-made sources, increases the risk of various types of malignancy including leukaemia and a number of solid tumours.

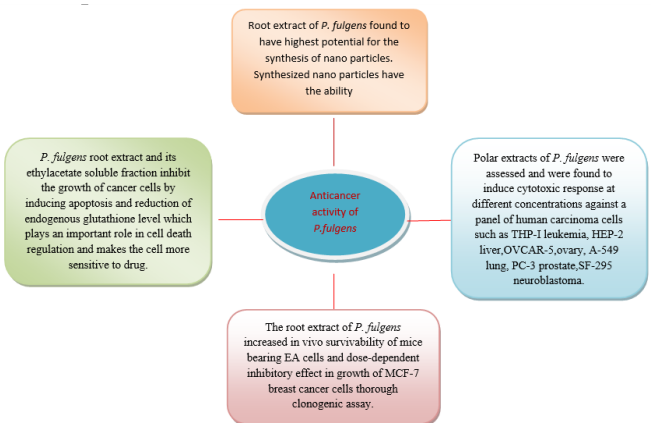
19. Chemoprevention of Cancer: A Rational and Appealing Strategy

Cancer chemoprevention is the use of natural, synthetic, or biological chemical agents to reverse, suppress, or prevent carcinogenic progression to invasive cancer [46]. Cancer chemopreventive agents can be classified in four major categories: hormonal, medications, diet-related agents, and vaccines. Primary chemoprevention refers to the use of an agent that prevents carcinogenesis in healthy individuals who are at higher risk, one the other hand secondary chemoprevention refers to preventing the full transition to malignancy in a patient who already has developed a premalignant lesion. Chemopreventive agents are subdivided into two main categories: (i) blocking agents, which inhibit the initiation step by preventing carcinogen activation and (ii) suppressing agents, which inhibit malignant cell proliferation during promotion and progression steps of carcinogenesis [47, 48]. Two major mechanisms of cancer prevention are antimutagenesis which includes the inhibition of the uptake of carcinogens, the formation/activation of carcinogens, the deactivation/detoxification of carcinogens, the blocking of carcinogen-DNA bindings, and the enhancement of fidelity of DNA repair [49].Another mechanism is antiproliferation/antiprogression that is the modulation of hormone/growth factor activity, the modification of signal transduction, the inhibition of oncogene activity, the promotion of the cellular differentiation, the modulation of arachidonic acid metabolism, and the enhancement of apoptosis [50].

20. Medicinal Plants and Cancer

The active substances or secondary metabolites found in a large number of medicinal plants which affect the uncontrolled cell division of medicinal plants are used for the treatment of cancer [51]. Chemotherapy is routinely used for the treatment of cancer. As cancer cells loose many of the regulatory functions present in normal cells, they continue to divide when normal cells do not which makes cancer cells susceptible to chemotherapeutic drugs [52]. A large collection of useful chemotherapeutic agents have already been established. However, chemotherapeutic treatments are not devoid of their own intrinsic problems. Various kinds of toxicities may occur as a result of chemotherapeutic treatments. For e.g. doxorubicin causes cardiac toxicity [53-55] renal toxicity [56] and myelotoxicity [57]. There are many significant plants well known for their multiple aspects of beneficial medicinal influence e.g *Taxus brevifolia* (Taxaceae), *Catharanthus roseus* (Apocynaceae), *Podophyllum peltatum* (Berberidaceae), *Camptotheca accuminata* (Cornaceae), and *Cephalotaxus harringtonia* (Cephalotaxaceae) [51]. Among them *Potentilla fulgens* is one of them. The National Cancer Institute (NCI) has screened approximately 35,000 plant species for potential anticancer activities. Among them, about 3,000 plant species have demonstrated reproducible anticancer activity.

21. Latest Report on Anticancer Activity of *P. fulgens* at a Glance



22. Role of Plant phytochemicals on Cancer

Due to the adverse effects produced by chemotherapy and radiation therapy, plant derived phytochemicals possessing anticancer activities have received considerable attention in recent years. The phytochemicals which are derived from traditional medicinal plants have been found to possess anticancer and chemo protective effects. Plant phytochemicals are in demand as they are safer for long-term use in cancer patients. Due to the effective antioxidant activity they provide nutrition and reduce the side effects of conventional cancer therapy. Antioxidant activities of the methanol extract, fractions and isolated compounds from the roots of *Potentilla fulgens* Lodd. were evaluated by three in vitro experiments, namely, ABTS, DPPH, and FRAP assays. PF-2 was characterized as a new bi-flavanoid and designated as Potifulgene on the basis of NMR and mass spectrum, whereas PF-1 was identified as epicatechin. The antioxidant activity of new biflavanoid (Potifulgene) was found to be higher than that of epicatechin with ABTS, DPPH and FRAP assays. Since *Potentilla fulgens* have antioxidant activity it is strongly associated with reduced risk of developing chronic diseases such as cancer as the phytochemical extracts from it exhibits strong antioxidant activity. The United States National Cancer Institute (NCI) instigated and fund a major screening programme, in which an intensive survey of plants, microorganism and marine animals for antitumour activity was investigated. Genistein (4, 5, 7-tribydroxy isoflavone) which is a soybean phytochemical inhibit the growth of transplantable human prostate carcinoma [59]. Andrographolide is a potential cancer therapeutic agent isolated from *Andrographis paniculata* [60]. An alcoholic extract of Biorhythms sensitivum for antitumor activity could inhibit the solid tumor deve ascites (DLA) cells and increase the life span of mice bearing Ehrlich ascites carcinoma (EAC) tumors [61].The natural antioxidant gallic acid (GA) isolated from the fruits of an Indonesian medicinal Plant, *Phaleria Macrocarpa* was proved to be a potent anticancer compound [62]. From ethyl acetate extract of *P.fulgens* gallic acid were isolated which acts as potential antioxidative and cancer chemopreventive agents [63].

23. Toxicity

Toxicity of chemotherapeutic drugs sometimes creates significant problem in the treatment of cancer using allopathy or established medicine. Various therapies have been profounded for the treatment of cancer many of which use plant-derived products because plant derived products have less cytotoxicity than therapeutic drugs. There are four classes of plant derived anticancer agents the vinca alkaloids (vinblastine, vincristine and vindesine), the epipodophyllotoxins (etoposide and teniposide), the taxanes (paclitaxel and docetaxel) and the camptothecin derivatives (camptotecin and irinotecan). The anticancer characteristics of a number of plants are still being actively researched and some have shown promising results. Among them *Potentilla fulgens*, which is found in Northeast part of India is still less known by people but have many potential medicinal values and anticancer characteristics.

24. Main Chemical Constituents of *P. fulgens* with Anticancer Properties

Compounds which have been identified and extracted from P. fulgens for their anticancer properties include polyphenols, flavonoids.

20.1 Polyphenols

Flavonoids, tannins, curcumin, resveratrol and gallacatechins are the polyphenolic compounds which are considered to be anticancer compounds [65]. The cytotoxicity of polyphenols on a range of cancer cells has been demonstrated as well as their antioxidant properties determined [65-67]. Polyphenols have apoptosis inducing properties anticancer properties which can be utilized. The mechanism behind which polyphenols are thought to carry out apoptosis initiation is through regulating the mobilization of copper ions which are bound to chromatin inducing DNA fragmentation [65]. Polyphenols also show their ability to interfere with proteins which are present in cancer cells and promoting their growth. Cancer agents is altered through the polyphenol regulating acetylation, methylation or phosphorylation by direct bonding of ions [68].

20.2 Flavonoids

Flavonoids are from the polyphenolic compounds and it constitute a large family of plant secondary metabolites [69]. Flavonoids demonstrate cytotoxicity on cancer cells and to have high free radical scavenging activity [69]. Purified flavonoids show anticancer activities against human cancers including; hepatoma (Hep-G2), cervical carcinoma (Hela) and breast cancer (MCF-7) [70]. Kaempferol (KMP) as flavonoids, ellagic acid (ELA) as polyphenols and methanolic extract of the root of *P. fulgens* (PRE)

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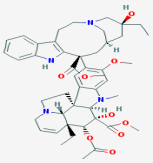
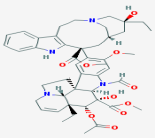
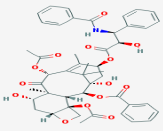
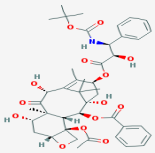
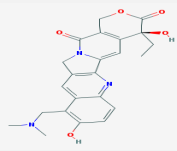
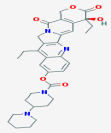
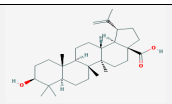
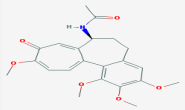
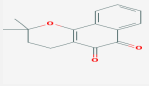
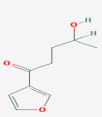
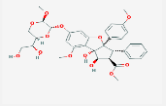
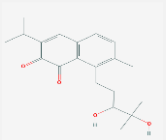
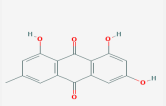
shows effectiveness in antitumor activity in Ehrlich ascites tumour (EA) and MCF-7(breast) cancer cells.

25. Plant Derived Bioactive Compounds as Leads to Anti-Cancer Drugs

Traditional medicines when compared to other sources of drug discoveries and other therapeutic drugs had contributed many novel therapeutic compounds for prevention and curative medicine. The secondary metabolites like polyphenols, terpenes, and alkaloids have been reported to possess antimutagenic and anticancer properties in many studies [71]. These secondary metabolites are also found to be present in different fractions of *Potentilla fulgens* root extract which shows *P. fulgens* as a potent source of anticancer agent also there is an enormous prospect for using it as a novel candidate and lead molecule in food and medicine industry as a natural alternative medicine. Traditional medicine derived from herbal medicinal plants and knowledge of Ayurveda help in the discovery of new drug leads with high activity and low toxicity for cancer therapy which focuses on the isolation of bioactive lead compounds, chemical modifications and improving pharmacological activity [72].

Plant-derived anti-cancerous compounds are divided into four major structural classifications viz., Vinca alkaloids, Epipodophyllotoxin lignans, Taxane diterpenoids and Camptothecin quinoline alkaloid derivatives. Some anticancerous drugs that have been identified and reported are - Vinblastine (VLB) and Vincristine (VCR), Podophyllotoxin, Taxane, Camptothecin (CPT), Berbamine, Betulinic acid, Berberine, Beta-lapachone, Betulinic acid, Bruceatin, Colchicin(Nirmala et al., 2011). Discovery of new drug is time consuming also laborious. So certain natural products and their analogs can be enhanced for anticancer activity by synthesizing new derivatives based on active pharmacophore models. The isolated lead molecules derived from medicinal plants are used as an alternative medicine for treating neoplastic cells [73].

Table 4 Some examples of secondary metabolites having anticancer activity

Drug	2D Chemical structure (adapted from Pubchem database)	Medicinal Use	Mechanism of action	Reference
Vinblastine		east, lymphoma, rm-cell d renal cancer	Inhibits cell proliferation by acts as mitotic block	[74]
Vincristine		ukemia,lympho a,breast, lung, diatric solid ncers and others	Inhibits cell proliferation by acts as mitotic block	[74]
Taxol		nticancer agent	Antimitotic agent	[75]
Docetaxal		east and lung ncer	Prevents mitosis by binding to microtubules	[76]
Topotecan		Ovarian, lung and ediatric ancer	Through inhibition of DNA topoisomerase I	[77]
Irinotecan		Colorectal and lung cancer	Through inhibition of DNA topoisomerase I	[78]
Betulinic acid		Normal cells and tissue are relatively resistant to Betulinic acid	They trigger the mitochondrial pathway of apoptosis which causes cancer cell death	[79]
Colchicine		ukemic and solid mors	It causes mitotic arrest during cell cycle	[80]
Beta-lapachone		Breast cancer, rostate cancer, ung cancer, ancreatic cancer and promyelocytic leukemia.	Inhibition of topoisomerase I and II	[81]
4-Ipomeanol		ng specific ncer in imal models	It causes cytochrome P-450-mediated conversion into DNA-binding metabolites. This monoterpene, cytotoxic agent showed promising result for lung-specific cancer in pre-clinical studies with animal models.	[82]
Silvestrol		Prostate, breast and lung cancer	apoptosome/mitochondrial pathway was involved in triggering extrinsic pathway of programmed cell death of tumor cells	[83]
Salvicine		Malignant tumors	Inhibition of topoisomerase II	[84]
Emodin		Lung, liver, ovarian and blood cancer	Apoptosis of cancer cells by several pathways	[85, 86]

26. Prospects

Healing with medicinal plants is as old as mankind itself. In recent time, there is a shift towards herbal cures. Currently medicinal plants are gaining significance due to the various phytochemicals present in them which helps in maintaining good health and used in various therapeutic treatments. Systematic evaluation of its anticancer efficacy was limited so more extensive studies using various analytical techniques have to be performed. It is necessary to investigate the effects of different fractions of *Potentilla fulgens* root extract in conventional medicines. Furthermore, investigation has to be done at molecular level to understand its mechanism of action. In depth phytochemical studies as well as pharmacological profile based on *in vivo* and *in vitro* and on clinical trials comparing the metabolic pattern is insufficient and further study should be done on the discovery of the exact mode of action of the various extracts prepared from Potentilla, the isolated pure compounds and potential combinations to utilize them pharmaceutically.

27. Conclusion

Potentilla fulgens is a significant medicinal herb which contains polyphenols in its stem, leaves and roots parts. High amount of tannins and a lesser extent of triterpenes are present in *Potentilla fulgens* which explained the pharmacological effects to a vast extent. Polyphenols, flavonoids, tannins are the chemical constituents which results in its anti-

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hyperglycemic, antihyperlipidemic, antitumor and antioxidant property. *Potentilla fulgens* extracts have been used for treating diarrhoea, hepatitis and rheumatism. Though *Potentilla fulgens* have served as an exemplary source of traditional medicine, it remains a challenge to provide for more efficient cheap medications for rural masses from this plant. Current pharmacological modalities for treating diabetes, diarhoea, hepatitis are not so much ideal and effective because of their side effects, reduction of response after prolonged use also expensive as well. So, the traditional way of using *Potentilla fulgens* and the plant extracts shows good remedy for a variety of ailments including cancer due to the presence of rich amount of phytochemicals in them. If all these studies are carried out in depth, this plant can be a very potent source for developing plant based anti-cancer remedy like taxol or vinca alkaloids.

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