

An Overview of *Plumbago Zeylanica*

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ABSTRACT

Many plants having great pharmacological potential are highly studied extensively *Plumbago zeylanica* (*Chitrak*) is one such plant. In the present article the complete phytochemical, pharmacological profile is detailed.

KEY WORDS: *Plumbago zeylanica*, *Chitrak*, Pharmacology

INTRODUCTION:

India has a rich tradition of plant-based knowledge on healthcare. "Traditional medicine is the sum total of knowledge, skills and practices based on the theories, belief and experiences indigenous to different cultures that are used to maintain health as well as to prevent, diagnose, improve or treat physical and mental illness". The classical systems of Indian Medicine especially Ayurveda, Siddha and Unani employed a large number of medicinal plants for treatment of skin diseases which includes cuts, wounds and burns.¹

The plant *Plumbago zeylanica* Linn. belonging to the family *Plumbaginaceae* known as *Chitraka/Chitramoolam* is a popular drug in Ayurveda and Siddha.² *Plumbago zeylanica* is a medicinal plant widely used in folklore medicine in Africa and Asia for the management of ailments such as parasitic diseases, scabies, ulcers, piles, diarrhea, skin diseases, leprosy, fever or malaria, rheumatism and intestinal parasites.³

CLASSIFICATION

Kingdom	: <i>Plantae</i>
Subkingdom	: <i>Viridiaeplantae</i>
Infrakingdom	: <i>Stereophyta</i>
Division	: <i>Tracheophyta</i>
Subdivision	: <i>Spermatophytina</i>
Infradivision	: <i>Angiospermae</i>
Class	: <i>Magnoliopsida</i>
Superorder	: <i>Caryophyllanae</i>
Order	: <i>Caryophyllales</i>
Family	: <i>Plumbaginaceae</i>
Genus	: <i>Plumbago</i> L.
Species	: <i>zeylanica</i> ⁴

Synonyms: *Plumbago scandens*, *Plumbago auriculata*, *Plumbago flaccida*, *Plumbago lactea*, *Plumbago virginica*, *Plumbago viscosa*.⁵

Common Names:

Arabic	: <i>Sheetraj, Shitraj</i>
Bengali	: <i>Chita, Sufaid, Chitruke, Chitarak, Chitra</i>
English	: <i>Lead Wort, Ceylon Lead Wort, White Flowered Lead Wort</i>
Gujarati	: <i>Chitrakmula, Chitaro, Chitrak</i>
Hawaiian	: <i>Lauhihi</i>
Hindi	: <i>Chira, Chitra, Chita, Chitarak</i>
Marathi	: <i>chitraka, chitramula</i>

Punjab	: <i>Chitra, Chitrak, chittra</i>
Tamil	: <i>Chitramulam, Kodiveli, Adigarvadi, Angodiveli, Koduveli</i>
Telugu	: <i>Chitramulam, Agnimata</i>
Urdu	: <i>Sheetraj Hindi, Cheetah, Chitalakri⁵</i>

HABIT: *Plumbago zeylanica* is an evergreen small perennial shrub which grows to a height of 3-4 feet. It is found in warm temperate-tropical regions of the world.⁶

HABITAT: The garden plant is growing wild in Bengal, U.P., Southern India and Ceylon. Found in the Sri Lanka, Assam, Bengal, and Uttar Pradesh.⁷

BOTANICAL DESCRIPTION:

The plant *P.zeylanica* is a small perennial shrub. Roots are long; tuberous; 30 cm or more in length; 6 mm or more in diameter; outer surface smooth; including root stocks; reddish to deep brown; scars of rootlets present; disagreeable odor and acrid taste. Powdered root is light yellow; agreeable smell and bitter taste; rough texture.⁸

STANDARDS:

Parameter	<i>P. zeylanica</i> (% w/w)
Loss on drying at 105°	8.18
Total Ash	3.11
Water-soluble ash	2.27
Acid-insoluble ash	0.96
Alkalinity of water-soluble ash	0.2 ml/g
Alcohol-soluble extractive	12.83
Water-soluble extractive	14.67
Crude fibre content	14.30

Values are mean of 3 readings⁹

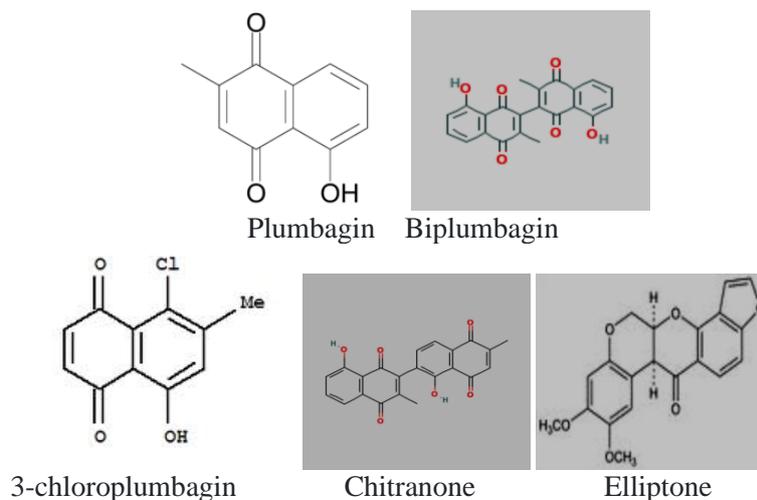
PHYTOCHEMICAL DETAILS:

The plant *Plumbago zeylanica* is composed of naphthoquinones like plumbagin, 3-biplumbagin, chloroplumbagin, chitranone, elliptone. The coumarins seselin, 5-methoxyseselin, suberosin and xanthyletin. Other compounds were 2, 2-dimethyl-5-hydroxy-6-acetylchromene, plumbagin acid, β sitosterol, β -sitosteryl-glucoside, bakuchiol, 12-hydroxyisobakuchiol, saponaretin, isoorientin, isoaffinetin, psorealen.¹⁰

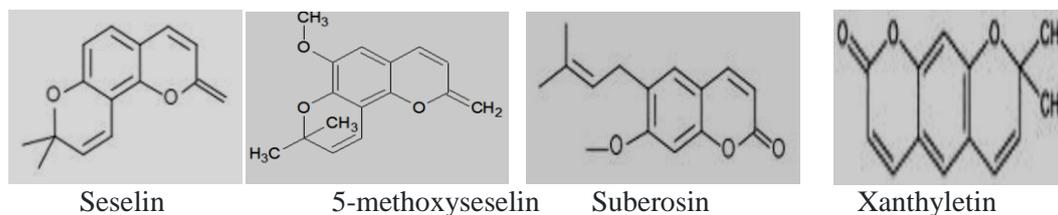
Roots of *P. zeylanica*: Two plumbagic acid glucosides, 3'-O- β -glucopyranosyl plumbagic acid and 3'-O- β -glucopyranosyl plumbagic acid methylester along with five naphthoquinones (plumbagin, chitranone, maritnone, elliptinone and isoshinanolone), and five coumarins (seselin, 5-methoxyseselin, suberosin, xanthyletin and xanthoxyletin) were isolated from the roots of *Plumbago zeylanica*. All coumarins were not previously found in this plant.

A raw phytochemical overview with thin layer chromatography of crude extracts showed the presence of alkaloids, phenols and flavonoids.¹¹

2. Naphthoquinones—



3. Coumarins—



PHARMACOLOGICAL PROPERTIES

Plumbago zeylanica plant is analgesic, anti-bacterial, anti-fungal, memory-inducing, anti-cancer, anti-inflammatory, hepatoprotective, larvicidal, anti-diabetic, anti-fertility, and immunosuppressive. The roots of the plant is used as an anti-oxidant.¹²

Analgesic activity: The ethanolic callus extract and root extract at dose 100, 200 and 400mg/kg were evaluated for peripheral and central analgesic activity by glacial acetic acid induced writhing. Root extract ($P < 0.01$) can reduce the writhing count at 200mg/kg whereas callus extract alters the pain threshold at 400mg/kg. Light creamish brown and granular callus formed with MS medium supplemented with naphthalene acetic acid (1.5 ppm) and kinetin (0.25 ppm) possessed peripheral analgesic activity.¹³

Antibacterial activity: The chloroform extract of *Plumbago zeylanica* L. root showed antibacterial activity against *Escherichia coli* (16.7 ± 0.14 mm), *Salmonella typhi* (14.3 ± 0.04 mm) and *Staphylococcus aureus* (12.0 ± 0.54 mm). Moderate inhibition shown against *Klebsiellapneumonia* (9.2 ± 0.73 mm), *Serratia marcescens* (8.6 ± 0.07 mm) and *Bacillus subtilis* (8.0 ± 0.61 mm), and lower against *Proteus vulgaris* (5.9 ± 0.55 mm) and *Pseudomonas aeruginosa* (4.8 ± 0.87 mm). The methanolic extract exhibited moderate activity while aqueous extract has been found weak against the bacterial strains.¹⁴

Antifungal activity: Plumbagin, the chief constituent found in the plant, at the concentration of 100 μ g inhibits the growth of fungal pathogens viz., *Cladosporium cladosporioides* (28.2 cm²), *Alternaria tunis* (12.5 cm²), *Botrydiplodia theobromae* (12.5 cm²), *Aspergillusniger* (12.5 cm²), *Fusariumoxysporum* (7.1 cm²), *Colletotrichum gloeosporioides* (5.4 cm²) and *Cercospora nicotinae* (5.3 cm²).¹⁵

Memory-inducing activity: The effect of *P. zeylanica* roots was employed on scopolamine induced amnesia for learning and memory of mice. The chloroform extract of plant at dose 200 mg/kg has shown promising memory enhancing effect in mice. The extract significantly reversed the amnesia induced by scopolamine (0.4 mg/kg i.p.)¹⁶

Anticancer activity: Anticancer evaluation of *Plumbago zeylanica* L. leaves against Ehrlich Ascites Carcinoma was done in animal model. Administration of the ethanolic extract of the leaves at concentration 200mg/kg reduced the tumour volume (3.42 ± 0.082), packed cell volume (1.05 ± 0.092) and viable tumour cell count % 107 cells/ml (4.85 ± 0.23) in a dose dependent manner.¹⁷

Anti-inflammatory activity: The methanolic extract of *P. zeylanica* roots tested for its anti-inflammatory effects at 300 and 500 mg/kg concentrations produced 31.03% and 60.30% ($P \leq 0.01$) inhibition of acute inflammation. The test carried out in carrageenan (1 in 0.5% CMC) induced rat paw oedema proved that methanolic extract of root is effective against acute inflammation (0.41 ± 0.061 ml and 0.23 ± 0.083 ml, respectively).¹⁸

Hepatoprotective activity: Triterpenes and sterols found in *P. zeylanica* is effective against paracetamol-induced hepatic toxicity. The blood samples taken from animals treated with petroleum ether root extract of the plant at the dose 300 mg/kg body weight has a significant protection against paracetamol induced hepatocellular injury.¹⁹

Larvicidal activity: The methanolic extract of *P. zeylanica* roots possesses larvicidal activity against two mosquito species, *Aedes aegypti* and *Anopheles stephensi*. The LC50 concentration against fourth instar larvae of *Aedes aegypti* and *Anopheles stephensi* was found to be 169.61 ± 7.99 mg/lit and 222.34 ± 8.65 mg/lit, respectively.²⁰

Antidiabetic activity: Oral administration of ethanolic root extract of *P. zeylanica* (100 mg, 200 mg/kg/p.o), tolbutamide (250 mg/kg/p.o) increased the activity of hexokinase and decreased the activity of glucose-6-phosphatase ($P < 0.001$) in streptozotocin treated diabetic rats.²¹

Antifertility activity: The acetone and ethanolic extracts of the leaves of *P. zeylanica* were most effective in interrupting the estrous cycle of the rats ($P < 0.05$) at dose levels 200 and 400 mg/kg. The animals exhibited prolonged diestrous stage of the estrous cycle corresponding to a temporary inhibition of ovulation. The anti-ovulatory activity was reversible on discontinuation of treatment.²²

Immunosuppressive activity: The aqueous root extract of *P. zeylanica* (1 mg) with ovalbumin (10 μ g i.p.) exhibited the significant suppression of ovalbumin-specific IgG antibody response (0.025 O.D at 4 nm) in BALB/c mice determined by enzyme-linked immunosorbent assay (ELISA) with dilution factor 1:400 for 56 days ($P < 0.05$). The extract (2 mg) with ovalbumin (10 μ g i.p.) also suppressed the anti-ovalbumin antibody response in dose-dependent manner (0.3 O. D at 490 nm).²³

Antioxidant activity: The isolation and spectral data for new flavonoid 2-(2, 4-Dihydroxy-phenyl)-3,6,8 trihydroxy chromen-4-one from the roots of *P. zeylanica* were determined and the antioxidant activity was studied by free radical scavenging and superoxide radical scavenging methods. The antioxidant activity by DPPH was found to be 96 μ g/ml and by NBT as 4.6 μ g/ml which were greater than that of standard (quercetin) 45 μ g/ml by DPPH and 10 μ g/ml by NBT assay.²⁴

Blood coagulation profile activity: The structure of active principle of the plant is similar to that of vitamin K. The plant extract (2 mg/kg body weight) and naphthoquinone (2 mg/kg body weight) given to individual groups were screened for its effect on bleeding time, clotting time, prothrombin time, platelet count and platelet adhesion in albino rats after 1-day, 15-day and 31-day treatment. The platelet adhesion was significantly decreased after plant extract and naphthoquinone-treated animals in both with and without blood volume reduction after 15th as well as 31st day. Even at a lower dosage level (2 mg/kg body weight), the chronic *P. zeylanica* administration prolongs the bleeding time by altering platelet adhesiveness and the coagulation.²⁵

Antiallergic activity: 70% ethanol extract of *P. zeylanica* stems show ability to inhibit mast cell-dependent immediate allergic reaction. This is evidenced by the fact that the extract could inhibit systemic anaphylactic shock induced by compound 48/80 in mice, reduce homologous passive cutaneous anaphylaxis and skin reactions induced by histamine or serotonin in rats. In vitro, the extract could reduce histamine release from rat peritoneal mast cells caused by compound 48/80 and antigen. It also markedly increased the intracellular cAMP content of rat mast cells.²⁶

Abortifacient activity: Treatment with powdered root of *P. zeylanica* during the first 7 days of pregnancy resulted in per implantation loss together with loss of uterine proteins of 13,000; 19,000 and 26,000 and 75,000 Da molecular weights. For those given the root from day 6 to day 17 of pregnancy proteins of molecular weights 55,000 and 65,000 Da were absent. This shows that proteins of 13,000; 19,000; 26,000 and 75,000 Da influence implantations while those of 55,000 and 65,000 Da are required for maintenance of pregnancy.²⁷

Lipid metabolism activity: Plumbagin was reported to reduce serum cholesterol and LDL-cholesterol by 53% - 86% and 61% - 91 % respectively; lower cholesterol/ phospholipid ration by 45.8%; elevates decreased HDL-cholesterol significantly in rabbits. It was also observed that plumbagin could prevent accumulation of cholesterol and triglycerides in liver and aorta and regressed atheroma plaques of thoracic and abdominal aorta. The treated rabbits excreted more faecal cholesterol and phospholipids.²⁸

TOXICOLOGICAL DETAILS:

Genotoxicity activity: Plumbagin, the most active compound in extracts of the roots of *P. zeylanica* was found to induce micronuclei at all doses studied (4mg/kg, 8mg/kg and 16mg/kg) and proved to be toxic to bone marrow cells of Swiss albino mice. Glutathione S-transferase (GST) activity was significantly inhibited by higher doses of plumbagin (8 mg and 16 mg/kg b.w.). While plumbagin by itself has genotoxic activity, the same investigator (Sivakumar et al) found that the alcoholic extract of the root of *P. zeylanica* in total proved to protect their Swiss albino mice from the genotoxic effects of cyclophosphamide. The extract instead significantly reduced the frequency of micronucleated polychromatic erythrocytes, increased the PCE/NCE ratio in the bone marrow, and decreased the levels of lipid peroxidation products with concomitant changes in the status of antioxidants. While plumbagin per se could cause genotoxicity, Demma et al proved that when in low dose (non-DNA damaging dose) in combination with NQNO or catechol, it could significantly reduce the catechol-induce DNA damage. This proves that the non-DNA damaging concentration of plumbagin diminished the DNA damage induced by catechol by an antioxidative action.²⁹

Toxicity study on plant extract of *Plumbago zeylanica* used in Ethiopian traditional medicine Toxicity studies done by Teshome K *et al*

This study showed that the primary irritant index to be 2.00 in rabbits; sensitization test in mice showed it to be non-sensitizer in the dose range of 4 – 10 mg/ml; acute dermal toxicity test on rats did not produce any overt signs of toxicity except for a weight gain difference between the test and control groups of female rats. Repeated dose toxicity test was associated with increased relative testes weight as well as higher values for Blood Urea Nitrogen and K+, an observation not supported by histopathological analyses.²⁹

CLINICAL UTILITY

The Chinese believes that *P. zeylanica* has the ability to increase digestive heat with fire like power. In Nepal, it is being used to treat dyspepsia, diarrhoea and haemorrhoids. In Ayurveda, the plant is recommended for removing worms, stimulating appetite, absorbing excess fluids from the intestines, destroying toxins and as a digestive. In Mauritius and Rodrigues Islands, the inhabitants recognized the roots as a remedy for diarrhoea and dyspepsia. Amongst the worms that succumb to it is the hookworm. In Ghana, the roots are applied as an enema for the treatment of haemorrhoids.³⁰

Respiratory diseases:

The Ayurvedic practitioners sometimes use the plant to treat cough and breathing difficulties. In Zimbabwe, an infusion of the roots is used for shortness of breath.³¹

S.NO	Activity	Part Used	Extraction	Animal Model	Dose (mg/kg)	P value	Reference & Year
1.	Anti-Hyperlipidemic activity	Roots	Aqueous	Rats	20, 40, and 80 mg/kg	<0.05	Sudha R. et al, (2009) ³⁷
		Roots	Ethanol	Rabbits	500 mg/Kg	<0.001	Alpana Ram, (1996) ³⁸
2.	CNS stimulatory activity	Roots	50% Ethanol extract	Rats	100, 200 and 300 mg/kg	<0.05	Bopaiah CP et al, (2001) ³⁹
3.	Anti-helicobacter pylori activity		Water, ethanol, Ethyl acetate, Acetone		5.12-20.48 mg/ml		Wang YC, Huang TL, (2005) ⁴⁰
4.	Genotoxicity	Stem	Acetone	Female albino rats	200mg/kg 400mg/kg	<0.05 <0.01 <0.001	Shingh SV et al, (2008) ⁴¹
		Roots (plumbagin)	-	Swiss albino mice (BMC)	4,8,16mg/kg		SivaKumar V et al, (2005) ⁴²
5.	Blood Coagulation activity	Whole plant		Albino rats	2mg/kg		Vijayakumar R et al (2006) ⁴³
6.	Anti-Trypanosomal activity & Cytotoxicity	root bark	Methanol	Vero cell line	250-1000 µg/ml 100-1.56 µg/ml		Bhanuprakash. V et al, (2006) ⁴⁴
7.	Contraceptive efficacy	Root	50% ethanol	Swiss albino rats	150mg/kg	<0.001	Ashok Purohit, et al, (2007) ⁴⁵
8.	Anti-Arthritic activity	Root	Ethyl acetate fraction	DBA/1 mice			Aparanji Poosarla, et al, (2007) ⁴⁶
9.	Acaricidal activity	Roots	Methanol	Amblyoma variegatum	2% extract	<0.01	Kofi Annan et al, (2009) ⁴⁷
10.	Hepatoprotective activity	Aerial parts	Hexane, CHCl ₃ , CH ₃ OH, Ether	Wistar rats	35mg/kg 70mg/kg	<0.05	Sushil kumar et al, (2009) ⁴⁸
11.	Anti-Fertility activity	Leaves	Methanol	Wistar rats	100mg/kg 200mg/kg	<0.01 <0.05 <0.001	G. Ramakrishnan Vinayaka, (2010) ⁴⁹
		Leaves	Acetone Ethanol	Female albino rats	200mg/kg 400mg/kg	<0.05	Edwin S, Joshi SB, Jain DC, (2009) ⁵⁰
12.	Analgesic activity	Callus Roots	Ethanolic	Swiss albino male mice	100, 200 400	<0.01	Vineet Mittal et al, (2010) ⁵¹
13.	Anti-Convulsant activity	Leaves	Hydroalcoholic	Albino wistar rats	250 500	<0.01	Vishnukanta, AC Rana, (2010) ⁵²

14.	Memory inducing activity	Roots	Chloroform	Swiss albino male mice	100mg/kg 200mg/kg 400mg/kg	<0.05	Vineet mittal, SharmaSK, Pawan.J, Anil.H, (2010) ⁵³
15.	Anti-Inflammatory & Cytotoxic activity	Roots	Methanol	Wistar rats	300mg/kg 500mg/kg	<0.01	R. Balaji Raja et al, (2010) ⁵⁴
			Dichloromet hane extract		50,100, 250,500pp m		
16.	Anti-Diabetic activity	Root	Ethanolic	Rats	100mg/kg 200mg/kg	<0.001	Zarmouh MM, Subramaniyam K et al, (2010) ⁵⁵
17.	Wound healing activity	Root	Methanol	Wistar albino rats	10% w/w	<0.05 <0.01	Devender Rao Kodati* et al, (2011) ⁵⁶
18.	Anti-Bacterial activity	Leaves	Methanol Chloroform	S.aureus,B.subtilis, P.aeruginosa,E.coli.	10µl 20 µl		M. Sudha Devi1* et al, (2011) ⁵⁷
19.	Anti-Cancer activity	Roots	Methanol	White albino male mice	20,50, 100,200, 300,500	<0.05	M.O. Raihan, A. Brishti, M.F. Islam et al, (2012) ⁵⁸
20.	Anti-Fungal activity	Whole plant	Methanol	Aspergillus niger, Blastomyces dermatitidis, C.albicans, Pityrosporum ovale,	250 µg/disc, 500 µg/disc	-	Dibyajyoti Saha*, Swati Paul, (2012) ⁵⁹
21.	Anti-Ulcer activity	Roots	Aqueous	Female inbred Balb /c (H-2d), C57BL/6 (H-2b) SWR/J (H-2q)mice	0.1mg, 1mg 2mg	<0.05	Chiu NY et al, (2010) ⁶⁰
		Root	Aqueous	Albino wistar rats	50mg/kg 100mg/kg	<0.05	Kakjing Dadul Falang et al, (2012) ⁶¹
22.	Antioxidant activity	Callus	Methanol	DPPH	40,80 120µg/ml		Kanungo et al, (2012) ⁶²
23.	DNA fingerprinting	leaf samples stored at -70° C	Modified CTAB method		10 ng/ µl		K.Dharmar et al, (2012) ⁶³

Gynaecological and obstetrical diseases:

The Malays provide decoction of the plant on the third day postpartum. The leaves are eaten as a vegetable as a measure of delaying menstruation. The illicit induction of abortion is done by giving a decoction of the roots; a practice which should be frowned upon by the society. In Africa, the pulped roots or aerial parts are inserted into the vagina to induce abortion; an dangerous practice which could result in death.³²

Genito-urinary diseases:

In Indonesia, the leaves are applied over the pubic region to help ease dysuria. The barks, roots or leaves are used to treat gonorrhoea and syphilis.³³

Inflammatory diseases:

In Ethiopia, the powdered bark, root or leaf is used to treat gonorrhoea, syphilis, and tuberculosis. The Zambians make use of the roots boiled in milk as a remedy for inflammation of the mouth, throat and chest. In Himachal Pradesh, the natives use a paste of the roots to induce drainage of abscesses. In Indonesia, it is used as an anti-rheumatic remedy by local application over the affected site. However, it has to be used with great caution because of its vesicant effects on the skin.³⁴

Skin diseases:

The decoction of the root is used for scabies. It is widely used to treat various skin diseases including leprosy, ringworms, dermatitis, acne, sores and ulcers. Most of the time the roots are the part that is being used for skin problems. However, care must be taken as it can also cause skin irritation and vesicular eruptions. Dried and pulverized root is a remedy for parasitic skin infestation. The paste of the root in vinegar, milk and water is used to treat influenza and black water fever in Africa.³⁵ Flowing is the pharmacological profile of *Plumbago zeylanica*.

Other uses:

Extract of the roots is used to treat hypertension in a Malay community. A paste of the roots is applied behind the ear to help relieve headache. Another way of relieving headache is by applying the root paste in the palate. Tincture of the root bark is an antiperiodic and a sudorific. The root cooked with meat in a soup is considered an aphrodisiac amongst the Zimbabwe people.³⁶

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