



## *Ichnocarpus frutescens*: A Precious Medicinal Plant

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### ABSTRACT

The plant *Ichnocarpus frutescens* belongs to family Apocynaceae, commonly known as 'Black creeper' (In Odia: Syamolota ; Hindi: Kali-dudhi, Krishna sariva; Sanskrit: Syamalata, Sariva). It is native to India, China, Java, Ceylon, Southeast Asia, and northern Australia. It is a large, evergreen, woody climbing plant sprawling to 10 meters in maximum length and 6 centimetres in diameter. It has been used for treatment of various disease & disorder like diabetes, demulcent, skin troubles, fevers, nephrolithiasis, seminal weakness, liver disorders etc. Reviewed phytochemical investigation of the plant showed the presence of flavonol, carbohydrate, phenolic acid, triterpene, steroid, natural rubber, proteins, oils, hydrocarbon, polyphenol etc. the divergent part of the plant shows numerous pharmacological activity such as antidiabetic, hepatoprotective, antioxidant, antitumor, wound healing, analgesic, antipyretic activities. The presented work aims to highlight a brief & comparative data on botanical, ethnopharmacological, phytochemical & pharmacological standards of plant *Ichnocarpus frutescens*.

**Keywords:** *Ichnocarpus frutescens*, Apocynaceae, Ethnopharmacological, Chemical constituents

### INTRODUCTION

India is a rich source of flora and fauna which is perhaps the largest source of medicinal herbs which is found in various hills and different parts of India. The different species of plant are used by tribals as well as local people to treat different diseases and disorders of human and animal. In Ayurvedic system of medicine Sariva is a well known drug and very important plant that has been widely used since ancient time. In Ayurvedic texts and other texts a number of plants are known by the name 'Sariva', that are *Hemidesmus indicus* (Linn.) R. Br. (Asclepiadaceae), *Ichnocarpus frutescens* R.Br. (Apocynaceae), *Cryptolepis buchanani* (Linn.) Roem and Schult. (Asclepiadaceae) and *Decalepis hamiltonii* Wight and Am. (Asclepiadaceae). *Hemidesmus indicus* is known as Sweeta Sariva and *Ichnocarpus frutescens*, *Cryptolepis buchanani* are known as Krishna Sariva<sup>1</sup>.

It is a large, evergreen, laticiferous, woody creeper with rusty red appearance, found almost throughout the India, ascending up to an altitude of 4,000 ft<sup>2</sup>. It also grows in Ceylon, China, Java and Australia<sup>3</sup>. The root of the plant are used in medicine as a substitute for Indian sarsaparilla (*Hemidesmus indicus*)<sup>2</sup>.

### Plant profile

#### Vernacular names<sup>1-5</sup>

Oriya : Syamolota, Madhobi, Soyamnoi  
 Hindi : Kali-dudhi, Siamalata, Krishna sariva  
 Sanskrit : Syamalata, Sariva, Paravalli, Krishna  
 Bengali : Dudhi, Syamalota  
 Marathi : Krishnssariva, Kantebhour

Telgu : Illukatte, Nalateage  
 Tamil : Paravalli, Udargodi  
 Malyali : Paralvally



**Figure 1:** *Ichnocarpus frutescens*

Kannada : Karehambu, Gorwiballi  
 Deradhun : Bel kamu  
 Assamese : Lamkandol, Paharukihandan  
 English : Black creeper  
 Tibetan : Thal tras nag po  
 Malaysia : Gerit jantan, Gerip jantan  
 Philippines : Sigid (Bisaya), Hinggiw (Tagalog), Sadak (Ilokano).  
 Burma : Tansapai (Myanmar)



Thailand : Khrua chen, Chai song, Po tohai.

**Synonyms<sup>4</sup>** : *Apocynum frutescens* Linn., *Echilios frutescens*

#### Systematic Classification<sup>6</sup>

Kingdom : Plantae  
 Subkingdom : Viridaeplantae  
 Phylum : Magnoliophyta  
 Subphylum : Euphylllophytina  
 Infraphylum : Radiatopses  
 Class : Magnoliopsida  
 Subclass : Magnoliidae  
 Superorder : Asteranae  
 Order : Gentianales  
 Family : Apocynaceae  
 Subfamily : Apocynoideae  
 Tribe : Apocyneae  
 Genus : *Ichnocarpus*  
 Species : *I. frutescens*  
 Binomial name : *Ichnocarpus frutescens* (L.) W. T. Aiton.

#### Plant facts<sup>7-9</sup>

Flowering and fruiting : Sept- Dec and Jan-April  
 Light : Full sun light  
 Moisture : Well drained soil  
 Propagation : By seeds and vegetative method  
 Altitude : 4,000 ft.

#### Botanical description

#### Macroscopical characters<sup>3, 7-9</sup>

The macroscopical characters of different parts of the plant have been summarised in table 1.

#### Ethnopharmacology

*Ichnocarpus frutescens* is used in medicines as a substitute for Indian Sarsaparilla (*Hemidesmus indicus*), it has been used as folk medicines which possesses various activities as mention in table2

#### Phytochemistry

Preliminary phytochemical examination of various extracts of *I. frutescens* revealed presence of polyphenols, terpenoids, alkaloids, phytosterols, carbohydrates, coumarins, glycosides, flavonoids, while, saponins, anthroquinones and steroids were absent<sup>44, 45</sup>

Phytochemical investigations on *I. frutescens* in various parts have yielded different phytoconstituents on their extraction and isolation is given in table 3.

**Table 1:** Macroscopical characters of *Ichnocarpus frutescens*

Parts	Description
Leaf	Evergreen, simple, opposite, alternate, lamina entire, pinnately veined, main nerves 5-7 pairs, exstipulate, elliptic-oblong to broadly lanceolate, acute or acuminate. Fresh leaf exudes creamy white latex, when injured or incised.
Stem	Woody cylindrical, herbaceous branched, climbing, rough, hairy, fresh stem exudes creamy white latex, when injured or incised.
Root	Tap root system, cylindrical, considerably long, 1-5 cm in diameter, irregularly bent, dark or dusty brown in colour, with fine longitudinal wrinkles on the surface. Short faint transverse cracks are also found at the bends. The fresh root is somewhat turgid and exudes plenty of creamy white latex, when injured or incised.
Inflorescence	Pedunculate cymose
Flower	Small, white or greenish white, fragrant, bracteate, bracteolate, pedicellate, complete, bisexual, actinomorphic, hypogynous, pentamerous.
Calyx	Sepals 5, gamopetalous, lobes ovate, acute without gland inside, fulvous hairy.
Corolla	Petals 5, gamopetalous, sometimes united only at the base, tubular or funnel-shaped, twisted aestivation often corolla tube appendaged within (bearded).
Androecium	Stamens 5, free, epipetalous, filament short, anthers bilobed.
Gynoecium	Carpels 2, ovary superior, style long, stigma capitate, ovary one pelled with to parietal placentation, plapeapae, many ovules in parietal plancented.
Fruit	A pair of follicles (cylindrical), slightly curved.
Seed	Seeds black, naked, long, linear, comose (with a tuft of silky hair at one side).

#### Pharmacological review

##### Leaves

Kumarappan C *et al.*<sup>59</sup> reported  $\alpha$ -Glucosidase inhibitory activity and *in vitro* antioxidant activities of alcohol-water extract (AWE) of *I. frutescens* leaves in the rats and found that the postprandial elevation in the blood glucose level after the administration of sucrose at the dose of 1000 mg/kg when compared with the control.



**Table 2:** Ethnopharmacology of *Ichnocarpus frutescens*

S.No.	Parts	Uses
1	Leaves	<p>Leaves are boiled in oil and applied in headache, wound and fever<sup>2</sup>.</p> <p>Decoction of leaves is used for fever and skin eruptions<sup>4</sup>.</p> <p>Decoction of a handful <i>I. frutescens</i> leaves is used for fever at a dose of 20 ml three times a day<sup>10</sup>.</p> <p>The tribal of Southern Rajasthan (India) used fresh leaf in Guinea worm disease and warmed leaves are applied over the swelling<sup>11</sup>.</p> <p>Decoction of dried <i>I. frutescens</i> leaves is used to treat Diabetes in Bangladesh<sup>12</sup>.</p> <p>Leaf is given to treat fever by the villagers in southern districts of Tamilnadu<sup>13</sup>.</p> <p>Stalks and leaves are used in the treatment of skin eruptions and fever by the people of Tumkur district, Karnataka<sup>14</sup>.</p> <p>Leaves extract is used in fevers, tongue ulcers, cramps, night blindness, and headache<sup>15</sup>.</p> <p>Leaf of the plant is used by the tribes of Chitrakoot, Madhya Pradesh on cuts to stop bleeding<sup>16</sup>.</p> <p>Leaf extract is used for stomach pain<sup>17</sup>.</p> <p>Leaves (boiled in oil) are applied for relief from headache, fever and wounds between fingers<sup>18</sup>.</p>
2	Stem	<p>Stem is used for fever and skin eruptions<sup>4</sup>.</p> <p>Decoction of a handful <i>I. frutescens</i> stem is used for redness of eye<sup>10</sup>.</p>
3	Roots	<p>Root is used as alterative, tonic, diuretic and diaphoretic, and for substitute of sarsaparilla<sup>4</sup>.</p> <p>Decoction of <i>I. frutescens</i> root is used as an antivenin in India<sup>19</sup>.</p> <p>Fresh root is used in dental caries in Marma Tribe of Bangladesh<sup>20</sup>.</p> <p>Decoction of root (about 100 gm. of fresh root is boiled in 1 litre of water for half an hour) is used as an antidote for snakebite at a dose of 5-10 ml every one or two hours<sup>21</sup>.</p> <p>The tribal's of eastern Rajasthan (India) used the roots for the treatment of rheumatic pain<sup>22</sup>.</p> <p>Decoction of roots is used as blood purifier by the tribal's of Santal Pargana (Bihar)<sup>23</sup>.</p> <p>Gond tribes of Patalkot and Tamiya (District: Chhindwara) are used roots as remedy for jaundice<sup>24</sup>.</p> <p>The Tribal's of Chotanagpur and Santhal Parganas of Bihar, India are used the roots of <i>I. frutescens</i> to cure stomach cancer in combination with the roots of <i>Bauhinia vahlii</i>, <i>Ardisia solanacea</i>, <i>Cissampelos pareira</i><sup>25</sup>.</p> <p>The dried root powder of <i>I. frutescens</i> is used as lactagogue and is administered about 10 g twice a day with a glass of fresh water after the meals by the tribal's of Sonaghati of Sonbhadra district, Uttar Pradesh<sup>26</sup>.</p> <p>The Root paste is applied by the villagers of Belgaum district, Karnataka in the rat bites and skin diseases<sup>27</sup>.</p> <p>The tribal's of Madhya Pradesh use the roots for cure diabetes<sup>28</sup>.</p> <p>Root is tied around the neck, it induce sound sleep<sup>29</sup>.</p> <p>The root is used in skin diseases in the district of Dehradun and Siwalik<sup>30</sup>.</p> <p>Roots of the plant are used as diuretic and diaphoretic<sup>31</sup>.</p> <p>Root of plant is used in fever, dyspepsia, skin troubles and has demulcent, alterative, tonics, diaphoretic and diuretic properties. Dried roots powder is used as blood purifier, antidiabetic and removal of stone in the bladder. They are useful in vitiated</p>



		<p>conditions of pitta, burning sensation, hyperdipsia, seminal weakness, nephrolithiasis, strangury, skin diseases, leprosy, pruritus, vomiting, cephalalgia and general weakness<sup>32</sup>.</p> <p>Root extract is used for vomiting in Kurichyas tribes of Kannur district, Western Ghats, Kerala<sup>33</sup>.</p>
4	Flowers	<p>About 10 flowers of <i>I. frutescens</i> are chewed and the juice swallowed every morning to cure diabetes<sup>34</sup>.</p> <p>Flowers are used to cure diabetes<sup>28</sup>.</p>
5	Latex	<p>The Siddis of Uttara kannada district, Karnataka, India, used leaf latex of <i>I. frutescens</i> to treat skin infections<sup>34</sup>.</p> <p>Latex of the plant, applied topically on painful tumours to reduce pain and retard growth<sup>35</sup>.</p>
6	Plants	<p>Plantis used in bleeding gums, convulsions, cough, delirium, dysentery, glossitis, haematuria, measles and night blindness. It is beneficial in anorexia, leucorrhoea, syphilis, urinary calculi and rheumatism<sup>4</sup>.</p> <p>Plant of <i>I. frutescens</i> is used as an aphrodisiac in Varanasi<sup>36</sup>.</p> <p>The plant is considered to be useful by the tribal's (Santals) in night blindness, bleeding gums, ulcerated tongue, sores, enlargement of spleen, atrophy, cachexia, convulsion, delirium, measles, small pox, haematuria, dysentery, cough, phthisis, dog bit, snake bite and spider-lick<sup>37</sup>.</p> <p>Whole plant is used in bone fracture, skin infection, diabetes and liver disorders<sup>38</sup>.</p> <p><i>I. frutescens</i> plant used in the treatment of bodyache by Rural people of Sagar Talukat of Shimoga District Karnataka<sup>39</sup>.</p> <p>Root powder taken with honey daily once for 2 - 3 months for minimization of excess of heat<sup>40</sup>.</p> <p>The plant is used for treatment of rheumatism, asthma, cough, bronchitis, bone fracture, cholera, constipation, dysentery, fever, night blindness, meseals, ulcer, vomiting, leucoderma &amp; also as febrifuge, blood purifier<sup>41</sup>.</p>
7	Combin-ation	<p><i>I. frutescens</i> root bark extract used in urinary disorders along with the root bark of <i>Zizyphus rogoza</i> with 1-2 spoonful sugar &amp; given twice a day<sup>42</sup>.</p> <p>The people of Bhadra wild life sanctuary in Karnataka use leaves of <i>Centella asiatica</i>, roots of <i>Ichnocarpus frutescens</i> and decoction of leaves of <i>Bambusa arundinacea</i> in the treatment of jaundice, diabetes and for expulsion of placenta in human's and animals<sup>43</sup>.</p>

Subash-Babu P C *et al.*<sup>60</sup> reported Insulin secretagogue effect of *I. frutescens* leaf extract in experimental diabetes (normal, glucose-fed hyperglycemic and streptozotocin- induced diabetic rats) and found that the oral administration of the methanolic extract of the leaf of *I. frutescens* leads to a significant blood glucose-lowering effect in glucose-fed hyperglycemic and diabetic rats. Oral administration of the methanolic extract of the leaf of *I. frutescens* daily for 45 d to diabetic rats significantly reduced the fasting plasma glucose to near normal. After 7 d of streptozotocin administration plasma insulin decreased in diabetic controls compared to normal controls. Histopathological examination showed that methanolic extract of the leaf of *I. frutescens* extract protected the pancreatic tissue from streptozotocin- induced damage enormously. Oral administration of methanolic extract and *n*-hexane

extract of the leaf of *I. frutescens* to normal and streptozotocin-induced diabetic rats decreased plasma glucose levels without hypoglycemic effect.

Kumarappan CT *et al.*<sup>61</sup> reported Polyphenolic extract of *I. frutescens* attenuates diabetic complications in streptozotocin-treated diabetic rats and found that, intraperitoneal glucose tolerance test revealed a significant decrease in blood glucose levels after glucose loading in rats fed with polyphenol extract of *I. frutescens*. A significant increase in TBARS (Thio-Barbituric acid reactive substances) level was observed in diabetic kidney, which was accompanied by a significant decrease in enzymatic and non-enzymatic antioxidant levels. After eight weeks, polyphenol extract of *I. frutescens* treated groups showed a lower level of blood glucose compared with non-treated streptozotocin-induced diabetic rats. The increases in urinary albumin



and protein after eight weeks of treatment were significantly inhibited by prolonged treatment with polyphenol extract of *I. frutescens*.

Kumarappan *Cet al.*<sup>62</sup> reported protective and curative effect of polyphenolic extract of *I. frutescens* against carbon tetrachloride and tamoxifen-induced hepatotoxicity in rats. Carbon tetrachloride and tamoxifen induced hepatotoxicity in rats found that there is a significant increment in the reduced glutathione levels with significant decrement in malondialdehyde and liver transaminases levels. Histopathological changes of liver sections showed that prophylactic and curative treatments with polyphenolic extract resulted in a relatively good protection against both carbon tetrachloride and tamoxifen intoxicated rats.

Majumder, MM *et al.*<sup>63</sup> reported 70% methanolic extract showed significant antioxidant activities in all assays in a dose dependent manner. The extracts displayed notable activities in reactive oxygen species (ROS) scavenging which could be attributed to the high phenolic content of this extract. Moreover, *I. frutescens* extract showed strong reducing power and an ability to suppress lipid peroxidation. Suppression of lipid peroxidation and nitric oxide scavenging would be the probable mechanism of the stabilization of the RBC membrane. In the DPPH radical scavenging assay the IC50 value of the extract was found to be 23.75 µg/ml. The extract inhibited the nitric oxide radicals generated from sodium nitroprusside.

Kumarappan CT *et al.*<sup>64</sup> evaluated antihyperlipidemic effects of the polyphenolic extract of *I. frutescens* leaves in alloxan-induced diabetic rats and found that administration of polyphenolic extract of the plant showed significant decrease in hepatic HMG-CoA reductase activity of alloxan in diabetic rats. Normoglycemic rats showed no significant effects. As per indication of hyperlipidemic indicators such as VLDL, HDL, LDL, TC & TGs. Polyphenolic extract found to possess hypolipidemic effect Oral administration of polyphenolic extract significantly enhanced the release of lipoprotein lipase enzyme significantly. Polyphenolic extract treated alloxan-rats pointed out complete recovery to normal condition during histopathological studies of aorta.

Kumarappan CT *et al.*<sup>65</sup> evaluated *In vivo* antitumor activity of polyphenolic extract of leaves of *I. frutescens* on Murine Ehrlich Ascites Carcinoma (EAC) model and *In vitro* cytotoxicity study in monocytoid leukemia (U-937) and erythro-leukemia(K-562) cell lines. *In vivo* study showed a significant decrease in tumor volume, viable tumor cell count and a significant increase of life span in the polyphenolic extract treated group compared to the untreated one. The life span of polyphenolic extract treated animals increased. *In vitro* study indicates that polyphenolic extract of the leaves of the plant effectively inhibits proliferation of U-937 and K-562 cell lines.

Kumarappan CT *et al.*<sup>66</sup> reported that the polyphenolic extract of *I. frutescens* showed significant Anti-carcinoma activity.

Suresh M *et al.*<sup>67</sup> reported the fresh leaf extract of *I. frutescens* showed antifilarial activity on *Anacardium occidentale*.

Saravanan M *et al.*<sup>68</sup> investigated antiobesity effect of the active sub fraction obtained from the leaves extract of *Ichnocarpus frutescens* (L.) R.Br. (Apocynaceae) using *in vitro* and *in vivo* models. The Sfr3 isolated from the hexane extract of *Ichnocarpus frutescens* showed the presence of  $\gamma$ -sitosterol as a major substance and the regulation of lipid metabolism both in adipocytes and hepatocytes provided strong evidence of Sfr3 in the management of obesity.

Saravanan M *et al.*<sup>69</sup> extracted leaves of *I. frutescens* with hexane, ethyl acetate, methanol & their effect were evaluated on viability of 3T3-L1 preadipocytes. The hexane extract inhibited cell viability in a time & dose related manner. An increased of LDH, as a marker of membrane integrity was observed at a dose of 200µg/ml. Morphological observations of cells stained with ORO showed a decrease in cellular lipid content at the concentrations tested compare to the induced control cells. The observed property clearly revealed the medicinal properties of *I. frutescens* in the treatment of obesity.

Prathib B *et al.*<sup>70</sup> evaluated the anticonvulsant activity of ethanol and aqueous extract (200mg/kg & 400mg/kg) of *I. frutescens* leaves in Swiss albino mice. The anticonvulsant activity was screened using maximal electro shock (MES) and Pentylene tetrazole (PTZ) models. Ethanol and aqueous extract of *Ichnocarpus frutescens* dose dependently produces significant antiepileptic activity in comparison to control. In MES method ethanol shows the significant activity compare to the aqueous activity. In PTZ method ethanol show the significant activity compare to the aqueous activity. The results were suggested that the Ethanol plant extract of *I. frutescens* having potent anticonvulsant activity higher dose (400mg/kg) of ethanolic extract showed better anticonvulsant activity when compared to lower dose (200mg/kg). Through modulating GABAergic system and oxidative stress in the rats brain which can be predicted due to the presence of different category of phytoconstituents.

Prathib B *et al.*<sup>71</sup> tested the leaf extract of *Ichnocarpus frutescens* belonging to the family Apocyanaceae for skeletal muscle relaxant activity. It was evaluated by rota-rod model and inclined screening test. It showed that the ethanolic extract of *Ichnocarpus frutescens* leaves possess a significant skeletal muscle relaxant activity in experimental Swiss albino mice. It showed marked skeletal muscle relaxant activity at dose of 200 mg/kg & 400mg/kg at 30, 60, 90, 120 min.



Bhanuprasad K *et al.*<sup>72</sup> evaluated *I. frutescens* (Apocynaceae) leaves extract against Isoproterenol induced myocardial infarction in wistar albino rats. Isoproterenol causes marked decrease in the levels of antioxidant enzymes and increase in the levels of cardiac marker enzymes and lipid peroxidation. The elevated levels of Cardiac marker enzymes such as aspartate amino transferase, alanine transaminase, *lactate dehydrogenase* and creatinine kinase were restored towards normalization significantly by *I. frutescens* in a dose dependent manner. It also produced a significant and dose-dependent reversal of Isoproterenol diminished activity of the antioxidant enzymes and also reduced elevated level of malanaldehyde.  $\alpha$ -Tocopherol was used as standard drug and *I. frutescens* extract (400mg/kg) produced significant effect compared to Isoproterenol and  $\alpha$ -Tocopherol treated Group.

Prathib B *et al.*<sup>73</sup> tested analgesic activity of various leaf extracts of *I. frutescens* using models namely and hot plate model. They concluded that ethanol and aqueous extract at the 400 mg/kg exhibited promising analgesic activity at 90 and 120 min when compare to control.

#### Root

Barik R *et al.*<sup>74</sup> reported aqueous root extract of *I. frutescens* possess antidiabetic activity in streptozotocin-nicotinamide induced type-II diabetes in rats and found significant result of reduction in fasting blood glucose levels on 10<sup>th</sup> and 15<sup>th</sup> days. In the oral glucose tolerance test, the extract increased the glucose tolerance.

Pandurangan A *et al.*<sup>75</sup> reported *In vitro* antioxidant activity of methanolic extract of roots of *I. frutescens* and found that methanolic extract of the plant exhibited strong scavenging effects on 2, 2-diphenyl-2-picryl hydroxyl (DPPH) free radicals, nitric oxide, super oxide anion, hydroxyl radicals and lipid peroxidation

Ashish *et al.*<sup>76</sup> evaluated *I. frutescens* (Apocynaceae) root extract, which was able to reduce the stable radical DPPH to the yellow coloured diphenyl picrylhydrazine. It showed highest 51.484% of inhibition at the 75  $\mu$ g/ml of extract concentration, whereas, the positive control (L-ascorbic acid) gives much higher 73.969% of inhibition at the same concentration. All aerobic organisms generate Reactive oxygen species (ROS) which are easily react with bio-molecules such as protein, lipids, lipoproteins and DNA. ROS responsible for generation of oxidative stress and many results many physiological disorders. Natural antioxidants can terminate or retard the oxidation process by scavenging free radicals.

Anbu J *et al.*<sup>77</sup> reported the inhibitory effect of the ethyl acetate extract of the roots of *I. frutescens* on nephrolithiasis induced in the rats and found that urinary excretion of oxalate, calcium and phosphate are significantly increased in calculi-induced rats as compared with normal control (saline) rats. Ethyl acetate extracts of the roots of *I. frutescens* significantly lowered

the deposition of oxalate, calcium and phosphate and the reduced the levels of uric acid, blood urea nitrogen and creatinine.

Pandurangan A *et al.*<sup>78</sup> evaluated methanolic extract of the roots of *I. Frutescens* R. Br for its antipyretic potential on normal body temperature and yeast-induced pyrexia in albino rats and found that methanolic extract of the root of plant produced significant reduction in normal body temperature and also decrease in elevated temperature induced by yeast in a dose-dependent manner. The effect extended up to 5 h after the drug administration.

Pandurangan A *et al.*<sup>79</sup> evaluated anti-inflammatory activity of the methanolic extract of the root of *I. frutescens* by carageenan- induced paw edema and cotton pellet-induced granuloma tests to determine its effects on acute and chronic phase of inflammation models in rats and found that methanolic extract of the root of *I. frutescens* showed maximum inhibition.

Ashish S *et al.*<sup>76</sup> investigated the antimicrobial activity, *in vitro* biochemical antidiabetic activity using  $\alpha$ -glucosidase inhibitory assay & *in vitro* biochemical antioxidant activity using by DPPH radical scavenging assay & superoxide radical scavenging activity of the ethyl acetate extract of *I. frutescens* roots. Which exhibited potential antibacterial activity against *Shigella dysenteriae* 1 (gram -ve), *Shigella flexneri* 16 (gram -ve), *Vibrio cholerae* non 0139 (L4) (gram -ve), *Vibrio cholerae* on 0139(CSK6669) (gram -ve), *Streptococcus pneumoniae* (gram +ve) and *Escherichia coli* (gram -ve). The extracts also indicate potential inhibitory activity against  $\alpha$ -glucosidase enzyme as compared to acarbose (+ve control) which indirectly showed antidiabetic activity. The extract also found potential superoxide radical scavenging activity compared to butylated hydroxyanisole (BHA).

Malathy NS *et al.*<sup>80</sup> investigated chloroform and aqueous extracts of *I. frutescens* roots to evaluate antimicrobial & antifungal activity. The chloroform extract showed highest antimicrobial and antifungal activities against *Escherichia coli* and *Aspergillus falvus* respectively. With the increasing in concentration of the extract a corresponding increase in diameter of zone of inhibition was observed.

Pandurangan *et al.*<sup>81</sup> evaluated the methanol extract of *I. frutescens* R. Br (Apocynaceae) roots for wound healing potential on different experimental models of wounds in rats. Methanolic extract ointment showed significant responses compared with the control group. The effect produced by the extract ointment, in terms of wound contracting ability, wound closure time, regeneration of tissues at wound site, tensile strength of the wound and histopathological characteristics showed significant effect as compare to standard drug like framycetin sulphate cream.



## Whole Plant

Das DK *et al.*<sup>82</sup> reported hepato-protective activity of *I. frutescens* (Linn.) R. Br. on paracetamol-induced hepatotoxicity in rats and found that Chloroform and methanol extracts produce significant hepato-protection by decreasing the activity of serum enzymes and bilirubin but methanolic extract at the same dose showed better effect than chloroform extract.

Dash DK *et al.*<sup>82</sup> evaluated antioxidant role of *I. frutescens* against Ehrlich ascites carcinoma in Swiss albino mice that showed significant antioxidant properties.

Dash DK *et al.*<sup>83</sup> evaluated antitumor activity of *I. frutescens* against Ehrlich ascites carcinoma in Swiss albino mice that showed significant Antitumor activity.

Starlin T *et al.*<sup>84</sup> evaluated the protective effect of ethanolic extracts of *I. frutescens* against 4-vinylcyclohexane induced ovarian cancer in Swiss albino mice and found that the ethanolic extracts of *I. frutescens* have effective anticancer activity.

Dhar ML *et al.*<sup>85</sup> evaluated cytotoxic activity of EtOH-H<sub>2</sub>O (1:1) extract of plant by cell cultured method.

Kajj-A-Kamb *et al.*<sup>86</sup> evaluated antiviral activity of ethanolic extract of entire plant that showed significant antiviral activity by cell cultured method.

Dhar MI *et al.*<sup>85</sup> evaluated toxicity assessment (quantitative) of ETOH-H<sub>2</sub>O(1:1) extract of entire plant and the maximum tolerated dose is 1.0 gm/kg wt of mouse.

Dhar MI *et al.*<sup>85</sup> reported that the EtOH-H<sub>2</sub>O(1:1) extract of entire plant at a concentration of 125.0 Mcg/ML showed significant antiamebic activity by broth culture of *Entamoeba histolytica*.

Ali MA *et al.*<sup>87</sup> reported that the aqueous extract of entire plant posses Nematocidal activity on *Toxocara caracanis* at 10.0mg/ml and 1.0mg/ml concentration.

## Leaf, Stem, Root

Ashutosh M *et al.*<sup>88</sup> investigated wound healing activities of plants *I. frutescens*. It's root hydro-alcoholic extract showed wound healing activity significantly in the excision wound model in rats on topical application. The results showed that hydro-alcoholic extract of *Ichnocarpus frutescens* stems on topical application reduced the scar area from 2.5±1.5 to 0.0±0.0 cm<sup>2</sup>, hydro-alcoholic extract of *I. frutescens* leaves on topical application was reduced the scar area from 2.5±1.5 to 0.2±0.0 cm<sup>2</sup>, hydro-alcoholic extract of *Ichnocarpus frutescens* roots on topical application reduced the scar area from 2.5±1.5 to 0.7±0.4 cm<sup>2</sup>, control on topical application was reduced the scar area from 2.5±1.5 to 1.2±1.0 cm<sup>2</sup> and standard povidon iodine ointment on topical application reduced the scar area from 2.5±1.5 to 0.5±0.02cm<sup>2</sup> respectively. Significant increases in tensile

strength were also observed as compared to the control and povidon iodine.

Mishra A *et al.*<sup>89</sup> evaluated Anti-inflammatory activities of 70% alcoholic extract of leaf, stem and roots of *I. frutescens* by carageenan- induced paw edema and found that anti-inflammatory activity of ethanolic extract of stem showed higher percentage of inhibition to reduce inflammation in comparison to leaf and root extract.

Mishra A *et al.*<sup>89</sup> evaluated analgesic effects of 70% alcoholic extract of leaves, stem and roots of *I. frutescens* in Wistar rats of either sex by hot plate and tail immersion methods and found that alcoholic extract of stem showed higher latency of percentage in comparison with alcoholic extract of leaf and root.

## Flower

Patwekar FI *et al.*<sup>90</sup> reported *In vitro* antioxidant activity of petroleum ether, chloroform, ethyl acetate and alcoholic extracts of flowers. Flavonoid isolated from thin layer chromatography from the ethyl acetate extract of flowers of *I. frutescens* found that it showed more free radicals and hydroxyl radicals scavenging activity with different extracts of the flowers of *I. frutescens*.

## CONCLUSION

The present study revealed *Ichnocarpus frutescens*, have a huge number of traditional & ethnomedicinal uses with a high therapeutic index value which makes it more acceptable & safer for treatment of numerous endemic. It is a stockpile of medicinally active useful chemical compounds which can be served as drugs. Various extract of leaf, root, stem, flower of the plant reported to have pharmacological activities such as diabetes, demulcent, skin troubles, fevers, nephrolithiasis, seminal weakness, liver disorders etc.

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