

## A BRIEF REVIEW OF PHARMACOLOGICAL ACTIVITIES OF FIRECRACKER PLANT (*RUSSELLIA EQUISETIFORMIS*)

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### ABSTRACT

*Russelia equisetiformis* is commonly known as firecracker plant. The name *Russelia* was given to the genus Scottish naturalist Alexander Russell (1715–1768) by the Dutch scientist Baron Nikolaus von Jacquin (1727-1817). It's a perennial plant. This article briefly reviews the common medicinal uses and also focused on various research carried on the different pharmacological activity claimed in the plant. This is an attempt to compile and document information on different aspects of *Russelia equisetiformis* and highlight the need for research and development.

**Keywords:** *Russelia equisetiformis*, Pharmacological Activities.

### INTRODUCTION

*Russelia equisetiformis* is an evergreen, perennial shrub with attractive looking, plants feature trailing, green stems and tubular red blossoms, formerly belonging to the polyphyletic family Scrophulariaceae and recently introduced into the new monophyletic family Plantaginaceae, is native to Tropical South America especially in Mexico.<sup>1-2</sup> The name *Russelia* honours the Scottish naturalist Alexander Russell. The species name reference to this plants resemblance to horse tail rushes, and the Latin term *equisetiformis* means like Equisetum. It is a deciduous, asparagus-like, many-branched, tropical sub shrub (to 4' tall) with trailing rush-like 4-angled stems and bright red tubular firecracker-like flowers (to 1.25" long) in drooping terminal cymes. Blooms freely from late spring to frost. Needle-like medium green leaves (to 1/2" long). Flowers are attractive to hummingbirds. Synonymous with *Russelia juncea*.<sup>3</sup>

### CLASSIFICATION

Kingdom :Plantae  
Division :Magnoliophyta – Flowering plants  
Class : Magnoliopsida – Dicotyledons  
Subclass : Asteridae  
Order : Scrophulariales  
Family :Scrophulariaceae  
Genus :Russelia Jacq.  
Species :*Russelia equisetiformis* Schltld.  
& Cham.

### COMMON NAMES

Coral fountain, Coral plant, Coral blow, Firecracker fern, Firecracker plant, Firecracker bush, Fountain bush.

### OTHER VERNACULAR NAMES

Coral plant, firecracker flower, fountain plant (English), Rasili (Hindi), Bao zhang zhu (Chinese), Plante corail (French), Coral de italia (Italian),

### ACTIVE CONSTITUENTS

Phytochemically, the plant has been reported to contain triterpenes of lupane type. Two phenylethanoid glycosides, russectinol and russeliaoside, were repeatedly reported and identified as active constituents of the plant. Likewise, total phenolic content has also been determined and quantified by Johnson and co-workers. Leaves yielded alkaloids, flavonoids, saponins, tannins, steroids, and terpenoids.<sup>4</sup> It has around 20 essential oil compounds, The major constituents are hexadecanoic acid methyl ester 11.04%, 11-methyltetracosane 8.44%, n-docosane 7.66%,  $\alpha$ -pinene 7.26%, octadecanoic acid methyl ester 6.37%, eicosanoic acid methyl ester 6.16%, ctadecanoic acid ethyl ester 5.69%, geranic acid 5.60%, methyl tetradecanoate 5.27%,  $\beta$ -pinene 4.60%. Phytochemical screening in extracts and fractions yielded alkaloids, steroids, tannins, terpenoids.

### MEDICINAL USES

*Russelia equisetiformis* is traditionally used in Nigeria to cure malaria, cancer, inflammatory disorders, diabetes, leukemia, and in hair preparations to promote hair growth. The fresh

entire plant decoction is taken orally to cure kidney stones in Colombia, and the whole plant is utilized as complementary therapy for DM2 patients in Mexico. Additionally anti-oxidant, anti-inflammatory, antinociceptive and analgesic properties were reported for different extracts of *Russelia equisetiformis*, as well as antibacterial, antimicrobial, cytotoxic, CNS depressant, hepatic function, membrane stabilizing.

## PHARMACOLOGICAL SCREENING

### • Antimicrobial

Antimicrobial effect of a methanolic extract was noted on *S. aureus*, *S. albus*, *S. typhi*, *P. aeruginosa* and *K. edwardsiella*. The effect was attributed to triterpenes in the extract.<sup>5</sup>

### • Diabetes / Leukemia

Phytochemical Screening of *Cnidioscolus Aconitifolius* and *Russelia Equisetiformis* Used for the treatment of Diabetes and Leukemia.<sup>6</sup>

### • Antinociceptive activity

This study examines the antinociceptive effect of the whole plant extracts of *Russelia equisetiformis*. The result shows the ethylacetate fraction to be the most active, while the dichloromethane fraction exhibited least activity. The major isolated compound from the ethylacetate showed a tremendous activity on acetic acid induced writhing with less activity on tail-flick response in mice. The structures of the two compounds were assigned on the basis of spectroscopic data. Occurrence of these compounds in *Russelia* is reported here for the first time, and the results confirm the traditional uses of *Russelia equisetiformis* in the treatment of inflammation and pain.<sup>7</sup>

### • Antiinflammatory / Analgesic activity

In a study of the methanolic extract of *Russelia equisetiformis* in rats and mice using carrageenan-induced rat paw edema, acetic acid-induced writhing and tail-flick testing, results suggested that the extract possesses potential anti-inflammatory and analgesic properties. The methanolic extract of *R. equisetiformis* (10–40 mg/kg, i.p.) exhibited a significant and dose-dependent inhibition of paw oedema induced by carrageenan in rats. It is possible that the effect of *R. equisetiformis* extract could result from an inhibitory action on the release of chemotactic agents or by inhibition of neutrophil migration. The extract showed significant ( $P < 0.05$ ) and dose-dependent analgesic activity. The extract caused inhibition of abdominal constriction at 10, 20 and 40 mg/kg.<sup>8</sup>

### • Hair-Growth Promoting Effect

The study demonstrated the hair growth promoting potential of the crude methanol extract of *Russelia equisetiformis*. The exact mechanism of action or the components responsible for the hair growth promoting activity in the plant extract could not be established in this study. Number of investigators have shown that flavonoids and triterpenoids possess hair growth promoting activity by strengthening the capillary wall of the smaller blood vessels supplying hair follicles, improve blood circulation to nourish the hair follicles and thereby promoting hair growth. Other workers also implicate flavonoids in stimulating telogen to anagen phase, a process involved in hair growth, and also cause expressions of some growth factors, such as insulin-like growth factor-1 (IGF-1), vascular endothelial growth factors (VEGF), keratinocyte growth factors (KGF) and hepatocyte growth factors (HGF), all of which has stimulatory effects on hair growth. It may be possible that the two phenolic compound & triterpenes contained in the plants extract are responsible for the observed hair growth promoting effect.<sup>9</sup>

### • Membrane Stabilizing Activity

The experimental evidence indicates that, the aqueous-ethanol extract of *Russelia equisetiformis* possesses membrane stabilizing property in a concentration-dependent manner. *Russelia equisetiformis* extract could serve as a useful supplementary therapy in haemolytic disease, and also in free radical-mediated oxidative cell injury conditions.<sup>10</sup>

### • Hepatic Function Impairment

The study showed that both aqueous and methanol extracts of *Russelia equisetiformis* have the potential to impair normal liver function in rats. This is indicated by the marked dose-dependent increase in serum levels of transaminases (ALT and AST), bilirubin and alkaline phosphatase (ALP) and a significant reduction in total protein level. These results were clear indication of cellular leakage and loss of functional integrity of the cell membrane. Free radicals and peroxidants have been implicated in the pathogenesis of toxic liver injury. Many of the drugs that precipitate liver disease produce free radicals during metabolism. *Russelia equisetiformis* has been reported to contain triterpenes and sterols, which could be sources of free radicals after metabolism. In addition, it has been reported that *Russelia equisetiformis* does not contain flavonoids, which have free radical

scavenging and antioxidant activities. Therefore, it is suspected that the free radical generated by the metabolism of *Russelia equisetiformis* accumulates and adversely affect liver function as indicated by an increase in the serum levels of liver enzymes.<sup>11</sup>

#### • Antioxidant, Antimicrobial and Cytotoxicity activity

*Russelia equisetiformis* extract and fractions showed significant antioxidant potential in terms of scavenging free radicals. The DPPH scavenging and linoleic acid oxidation assays showed the antioxidant potential of the plant. The methanol extract by H<sub>2</sub>O<sub>2</sub> induced oxidative damage in plasmid pBR322 DNA was evaluated and it was found that it protected the DNA, which may be due to the presence of phytochemicals which showed antioxidant properties.

The potential of the extract and fractions against selected bacterial and fungal strains showed antimicrobial properties. The cytotoxicity of the plant extract and fractions were assayed by haemolytic activity against human RBCs and the percentage lysis studied in vitro. It was observed that the plant may have a minor cytotoxicity as the percentage lysis of RBCs was found to be below 5.0%. Due to the minor cytotoxicity the plant may be used as an herbal medicine.<sup>12</sup>

#### • CNS Depressant Activity

A Study was conducted to evaluate crude methanol extracts and fractions of *Russelia equisetiformis* in mice using amphetamine-induced stereotypy, picrotoxin-induced convulsion & phenobarbitone sleeping time. Results showed central nervous system depressant activities.

The experiment showed that in mice, as the dose of *Russelia equisetiformis* increased from 100 mg/kg to 400 mg/kg, the time spent sleeping increased & the time it took to change into the sleep stages other than REM sleep decreased. However, this plant taken in large doses such as 400 mg/kg led to the death of the mice on amphetamine which is a stimulant on the CNS. The high dosage of *Russelia equisetiformis* which is suspected to act as a dopamine receptor blocker along with the amphetamine would lead to convulsions and cause serious brain damage resulting in the animal's deaths. The smaller doses of 100 & 200 mg/kg had longer amount of time before the onset of seizure. Overall, the experiment shows that *R. equisetiformis* is a depressant on the central CNS & acts by blocking the neurotransmitter GABA.<sup>13</sup>

#### • Anti-Inflammatory

Study isolated lupeol. The lupeol extract showed significant & dose-dependent anti-inflammatory activity in acute and chronic models of inflammation viz egg albumin-induced paw edema, formaldehyde-induced arthritis & cotton pellet granuloma in vivo tests. Prednisolone was used standard drug.<sup>14</sup>

#### • Anticonvulsant activity

Study of methanol extracts of RE for anticonvulsant activity using picrotoxin (PCT) showed significant protective activity against picrotoxin, probably through GABAergic neurotransmission or facilitating GABAergic action in the brain. Results suggest a potential use as supplementary therapy for management and/or control of childhood convulsions & epilepsy.<sup>15</sup>

#### • Antimalarial activity

The ethanol extracts of *Russelia equisetiformis* show some intrinsic antimalaria activity by its percentage chemo suppression and prophylactic ability against chloroquine-resistant P. Berghi parasites. This performance can surely be improved upon in future studies if the crude extract is purified and the active substituents identified. The extracts have considerable low or no toxicities in experimental mice. Acute toxicity tests with the extracts have also demonstrated their safety because the highest dose used for the screening did not cause death. Interestingly, the highest dose used to treat parasite-infected mice, which elicited antimalarial activity, was much lower than the highest acute dose. This findings support the traditional use of this plant for the treatment of malaria.<sup>16</sup>

#### Free radical scavenging activity

The methanol extract of *Russelia equisetiformis*, which exhibited significant antiinflammatory activity, was evaluated for the possible mode of action by studying its antioxidant potential in adjuvant-induced arthritic rats. 1, 1 diphenyl-2-picrylhydrazyl (DPPH) radical scavenging effect was determined by spectrophotometric method. The enzymatic activity of the superoxide dismutase, glutathione peroxidase, showed a significant increase, while the lipid peroxide content was found to decrease to a large extent in MRE and indomethacin-treated rats. There was also significant and concentration-dependent increase in the percentage inhibition of DPPH, comparable to that of vitamin E and butylated hydroxyanisole (BHA) which are natural and synthetic antioxidants,

respectively. The results obtained in the present study indicate that MRE possesses free radical scavenging and antioxidant properties.<sup>17</sup>

#### Anthelmintic Properties

*in vitro* anthelmintic activity of *Russelia equisetiformis* leaves in comparison with anthelmintic drug Piperazine citrate was studied. *In vitro* Anthelmintic activity of different solvent extracts (petroleum ether, chloroform, ethyl acetate and methanol) of *Russelia equisetiformis* were carried out on mature *Pheretima posthuma*. The results of the study revealed that all the solvent extracts produced a significant anthelmintic activity in a dose-dependent manner. Methanol extract offered a good anthelmintic activity at 15 mg/ml concentration, where the time of paralysis was 15 and death was observed at 27 min, followed by ethyl acetate extract. The negative control DMF did not show any activity and positive control standard piperazine citrate recorded death at 13 min and paralysis at 10 min.<sup>18</sup>

#### Antipyretic Activity

Screening of antipyretic activity was carried out in animal model, where pyrexia was induced by subcutaneous injection of 20% w/v yeast aqueous suspension in the back, below the nape of the neck. After 18 hours, the same grouping of animals in the anti-inflammatory study and their respective treatment were followed except group 2 (positive control) which received acetyl salicylic acid 100 mg/kg as the reference drug in vehicle orally. The rectal temperature before and after treatment, which was recorded with the help of a digital thermometer at every hour up to four hours, was compared with control. The experimental evidence indicates that, the extract of *Russelia equisetiformis* possesses antipyretic activity.<sup>19</sup>

#### Hepatoprotective properties

Data obtained from this study show that *Russelia equisetiformis* plant extract may possess significant hepatoprotective activities on toxicant induced liver damage in the experimental models and thereby offer useful prophylactic measure. Hepatoprotective activity of *Russelia equisetiformis* could be due to membrane stabilizing and free radical scavenging activities.<sup>20</sup>

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