

Anti-Arthritic Activity of *Premna serratifolia* Linn., Wood against Adjuvant Induced Arthritis

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Abstract

Adjuvant induced arthritis is a chronic crippling, skeleton-muscular disorder having nearest approximation to human rheumatoid arthritis for which there is currently no medicine available effecting a permanent cure. Even modern drugs used for the amelioration of the symptoms, offer only temporary relief and also produce severe side effects. In the indigenous system of medicine, wood of *Premna serratifolia* Linn., is reported to be useful in the treatment of arthritis. It is a large shrub, distributed throughout Asia, used against a wide variety of diseases. However, no systematic study has been reported regarding its anti-arthritic activity. This work was aimed at the scientific validation of the ethno-pharmacological claim about its anti-arthritic property. In the present study, anti-arthritic activity of ethanol extract of *Premna serratifolia* Linn., wood is done by Freund's adjuvant induced arthritis model. Loss in body weight during arthritis condition was corrected on treatment with ethanol extract and standard drug, indomethacin. Biochemical parameters such as hemoglobin content, total WBC, RBC, erythrocyte and sedimentation rate were also estimated. The ethanol extract at the dose of 300 mg/kg body weight inhibited the rat paw edema by 68.32% which is comparable with standard drug indomethacin 74.87% inhibition of rat paw edema after 21 days. The results of the current investigation concluded, ethanol extract of *Premna serratifolia* Linn., wood possess a significant anti-arthritic activity against adjuvant induced arthritis and justifying its therapeutic role in arthritic condition. The observed anti-arthritic activity may be due to the presence of phytoconstituents such as irridiod glycosides, alkaloids, phenolic compounds and flavonoids.

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Introduction

Premna serratifolia Linn., (Verbenaceae) is an important plant belonging to the family Verbenaceae, and is one of the most widespread large shrubs in the forests of India, usually occurring in deciduous forests. The whole plant possesses medicinal properties,

useful in the treatment of cardiovascular diseases, skin diseases, inflammatory diseases, arthritis, gonorrhea, rheumatism, anorexia and jaundice. It is an important Ayurvedic medicinal herb and its synonym is *Premna integrifolia*. It is popularly known as

“Munney” in Tamil, and “Agnimantha” in Ayurvedic system of medicine. Root forms an ingredient in well known Ayurvedic formulation “Dasamula” which is used for variety of affections ⁽¹⁾. It is widespread throughout Micronesia and much of the tropical Pacific and tropical Asia. It is common along the Indian and Andaman coasts. Infusion of the leaves is administered with pepper in cold and fever. Leaves are used to cure "weakness of limbs" and the leaves and leaf sap were used to alleviate headache ⁽²⁾.

Premna serratifolia Linn., has cardiotoxic ⁽³⁾, anti-coagulant ⁽⁴⁾, anti-inflammatory ⁽⁵⁾, anti-hyperglycaemic ⁽⁶⁾, anti-parasitic ⁽⁷⁾, antioxidant ⁽⁸⁾ and antimicrobial ⁽⁹⁾ properties. Most of the plant parts of *Premna serratifolia* Linn., have been used in the traditional system of medicine in India to treat various infectious diseases. Adjuvant induced arthritis is a chronic crippling, skeleton-muscular disorder having nearest approximation to human rheumatoid arthritis for which there is presently no medicine available effecting a permanent cure. The modern drugs both steroidal and non-steroidal anti-inflammatory drugs are used for the amelioration of the symptoms of the disease, however they offer only temporary relief and also produce severe side effects ⁽¹⁰⁾. In the Ayurvedic system of medicine, this plant has been used in the treatment of rheumatoid arthritis ⁽¹⁾.

Literature survey revealed that there is no systematic study regarding the anti-arthritic activity of the wood of *Premna serratifolia*. Hence in the present study, an attempt has been made to evaluate the anti-arthritic activity of the ethanol extract of wood of *Premna serratifolia* Linn., using adjuvant induced arthritis in rats.

Materials and Methods

Plant material

Fresh wood (without bark) of *Premna serratifolia* Linn., was procured from The Indian Medical Practitioners Co-operative Pharmacy and Stores (IMPCOPS) garden, Thiruvanimiyur, Chennai, Tamil Nadu. The plant was

identified ⁽¹¹⁾, authenticated by Botanist, Dr. P. Jayaraman, Plant Anatomical Research Centre (PARC), Tambaram, Chennai and the voucher specimen (PARC/ 2007/ 71) have been kept in the Department of Pharmacognosy, Madras Medical College, Chennai, for future reference. Care was taken to select the healthy plants and for normal organs.

Extraction

The freshly collected wood was chopped, shade dried and coarsely powdered (40 mesh size). The powder was defatted with petroleum ether (60 - 80 °C) and then extracted with 90% ethanol in a Soxhlet extractor. The extract was dried under reduced pressure using a rotary vacuum evaporator and the percentage yield was 7.90% w/w. The obtained ethanol extract was suspended in 5% gum acacia for the pharmacological screening.

Phytochemical screening

Phytochemical screening ⁽¹²⁾ of the extract was performed using the following reagents and chemicals: Alkaloids with Dragendorff's reagent, flavonoids with magnesium and hydrochloric acid, tannins with ferric chloride and potassium dichromate, Trim-hill test for iridoid glycosides, Libermann-Burchard test for steroids and for phenolic compounds with ferric chloride.

Animals

For acute toxicity and anti-arthritic activities, Wistar albino rats weighing between 150 - 200 gm were selected. The animals were acclimatized to the standard laboratory conditions (temperature 25±2 °C) and maintained on 12 hr light, 12 hr dark cycle. The animals were fed with standard diet and water *ad libitum*. The animals were maintained as per the norms of CPCSEA and the experiments were cleared by CPCSEA and the institutional ethics committee.

Acute toxicity studies

Acute toxicity study was performed for methanol extract according to the acute toxic classic method as per OECD guidelines ⁽¹³⁾. Female albino rats were used for acute toxicity study. The animals were kept fasting for

overnight providing only water, after which the extract was administered orally at the dose of 300 mg/kg and observed for 14 days. If mortality was observed in two animals out of three animals, then the dose administered was assigned as toxic dose. If the mortality was observed in one animal, then the same dose was repeated to confirm the toxic dose. If mortality was not observed, the procedure was repeated for further higher doses such as 50, 200 and 2000 mg/kg body weight. The animals were observed for toxic symptoms such as behavioral changes, locomotion, convulsions and mortality for 72 hr.

Anti-arthritic activity

Freud's adjuvant induced arthritis⁽¹⁴⁾ model was used to assess the anti-arthritic activity in albino rats. Animals were divided into three groups of six animals each. Group I served as control, which received 5% gum acacia suspension, Group II served as reference standard, which received 10 mg/kg body weight IP of indomethacin, and Group III served as test, which received the ethanol extract of *Premna serratifolia* Linn., wood at the dose of 300mg/kg body weight PO, respectively.

Arthritis was induced by injecting 0.05 ml of suspension of killed *Mycobacterium tuberculosis* bacteria (0.5% w/w) homogenized in liquid paraffin into the left hind paw. Drug treatment was started from the initial day i.e. from the day of adjuvant injection (0 day), 30 min before adjuvant injection and continued till 21st day. Paw volume was measured on 4th, 8th, 14th and 21st day with the help of Plethysmometer.

The mean changes in injected paw edema with respect to initial paw volume, were calculated on respective days and percentage

inhibition of paw edema with respect to untreated group (control) was calculated using the formula: Percentage inhibition of paw edema = [1 - (mean change in paw volume of treated rat/ mean change in paw volume of untreated rat)] x 100.

The changes in body weight were recorded daily. On the 22nd day, blood was withdrawn through retro-orbital vein puncture of all groups by anaesthetizing the animals with diethyl ether and the biochemical parameters such as hemoglobin content, total WBC count, ESR and RBC were analyzed.

Statistical analysis

Results were expressed as mean ± SD. The significance of difference among the groups was assessed using One way analysis of variance (ANOVA) followed by Dunnet's test. P<0.05 was considered significant.

Results

The results of the preliminary phytochemical screening of the ethanol extract of *Premna serratifolia* Linn., revealed the presence of phytoconstituents such as alkaloids, steroids, flavonoids, phenolic compounds, tannins and glycosides specifically iridoid glycosides.

In acute toxicity studies, the ethanol extract of *Premna serratifolia* Linn., did not produce any toxic symptoms or mortality up to the dose level of 2000 mg/kg body weight in rats, and hence the extract was considered to be safe and non-toxic for further pharmacological screening. In adjuvant induced arthritis model, rats developed a chronic swelling in multiple joints with the influence of inflammatory cells, erosion of joint cartilage and bone destruction and remodeling.

Table 1. Mean changes in paw volume using Plethysmometer in adjuvant-induced arthritis in rats

Treatment	4 th day	8 th day	14 th day	21 st day
Group I (Arthritic control)	5.26±0.26	5.34±0.20	5.24±0.21	5.13±0.22
Group II (Standard drug)	4.63±0.15 ^{a*}	3.95±0.25 ^{a*}	3.13±0.29 ^{a*}	1.31±0.18 ^{a*}
Group III (Ethanol extract)	4.69±0.22 ^{a*}	4.1±0.24 ^{a*}	3.19±0.29 ^{a*}	1.61±0.11 ^{a*}

n=6, values are expressed as mean±SEM, p<0.05 - significant, ^{a*}p<0.01 - more significant when compared to the control

Table 2. Percentage inhibition of paw volume in adjuvant-induced-arthritis in rats

Treatment	4 th day	8 th day	14 th day	21 st day
Group I (Arthritic control)	0	0	0	0
Group II (Standard drug)	11.41	25.84	40.59	74.87
Group III (Ethanol extract)	10.91	23.30	38.74	68.32

These inflammatory changes ultimately result in the complete destruction of joint integrity and functions in the affected animal⁽¹⁵⁾. The ethanol extract inhibited the rat paw edema by 68.32%, which is comparable with standard drug, indomethacin 74.87% inhibition of rat paw edema after 21 days (Tables 1 and 2). As shown in table 3 standard drug, indomethacin and the ethanol extract have shown to increase the hemoglobin content when compared to control group. The total WBC counts were remarkably increased in adjuvant-induced rats (Table 3-control group).

However, *Premna serratifolia* Linn., wood ethanol extract and the standard drug treated groups significantly decreased ($p < 0.01$) the total WBC count. The ESR count, which drastically increased in arthritic control group, has been remarkably counteracted by the standard drug; indomethacin and ethanol extract, restoring it back to normal, thus justifying its significant roles in the severe arthritic conditions. The loss of body weight observed during the arthritis condition, which

is in the arthritic control group, the standard drug and the ethanol extract treatment has significantly increased the body weight further confirming the significant anti-arthritic activity of the ethanol extract of *Premna serratifolia* Linn., wood and it is shown in the table 4.

Discussion

In the present study, the rats were selected to induce arthritis because rats develop a chronic swelling in multiple joints with the influence of inflammatory cells, erosion of joint cartilage and bone destruction. It has close similarities to human rheumatoid disease⁽¹⁶⁾. The determination of rat paw swelling is apparently simple, sensitive and one of the quick procedures for evaluating the degree of inflammation and the therapeutic effects of drugs. The chronic inflammation involves the release of number of mediators like cytokines, GM-CSF, interferons and PGDF. These mediators are responsible for the pain, destruction of bone and cartilage that can leads to severe disability⁽¹⁷⁾. However, the standard drug, indomethacin and the ethanol extract significantly suppressed the swelling of the rat paws.

In arthritic condition, there is a mild to moderate rise in WBC count due to the release of IL-1B inflammatory response, IL-1B increases the production of both granulocyte

Table 3. Effect on hematological parameters in adjuvant-induced arthritis in rats

Treatment	Total WBC count (cells/cu.mm)	RBC count (million/cu.mm)	Hb (gm%)	ESR (mm/hr)
Group I (Arthritic control)	7.85±0.08	5.2±0.1	13.7±0.2	4.05±0.1
Group II (Standard drug)	7.15±0.1 ^{a*}	5.22±0.1 ^{a*}	14.08±0.1 ^{a*}	3.25±0.1 ^{a*}
Group III (Ethanol extract)	7.03±0.08 ^{a*}	5.58±0.1 ^{a*}	14.5±0.1 ^{a*}	3.22±0.1 ^{a*}

n=6, values are expressed as mean±SEM, $p < 0.05$ - significant, ^{a*} $p < 0.01$ - more significant when compared to the control

Table 4. Changes in the body weight in adjuvant-induced arthritis in rat

Groups	Before induction (gm)	On 21 st day (gm)	Mean changes in the body weight
Group I (Arthritic control)	158	166	8.33±1.66
Group II (Standard drug)	155	195	40±2.6 ^{a*}
Group III (Ethanol extract)	150	174	23.3±1.5 ^{a*}

n=6, values are expressed as mean±SEM, $p < 0.05$ - significant, ^{a*} $p < 0.01$ - more significant when compared to the control

and macrophages colony stimulating factors^(17, 18). In the present study, the migration of leucocytes into the inflamed area is significantly suppressed by ethanol extract when compared to standard drug indomethacin, as seen from the significant reduction in the total WBC count.

Erythrocyte Sedimentation Rate (ESR) is an estimate of the suspension stability of RBC's in plasma. It is related to the number and size of the red cells and to the relative concentration of plasma proteins, especially fibrinogen, alpha and beta globulins. Increase in the rate, is an indication of active but obscure disease processes. The acute phase proteins in ESR and C-Reactive Proteins (CRP) share the property of showing elevations in the concentration in response to stress or inflammations like injection, injury, surgery and tissue necrosis. The ESR count significantly increased in arthritic control group, whereas these counts were remarkably counteracted in the standard, indomethacin and ethanol extract groups and thus justifying its significant role in the arthritic conditions⁽¹⁸⁾.

Changes in body weight have also been used to assess the course of the disease and the response to therapy of anti-inflammatory drugs⁽¹⁹⁾. As the incidence and severity of arthritis increased, the changes in the body weights of the rats also occurred during the course of the experimental period. The loss of the body weight during arthritic condition was also supported by earlier observations,⁽²⁰⁾ on alterations in the metabolic activities of diseased rats.

Earlier findings suggest that absorption of ¹⁴C-glucose and ¹⁴C-leucine in rat's intestine was reduced in the case of inflamed rats⁽²¹⁾. Treatment with anti-inflammatory drugs, the decrease in absorption was nullified⁽²²⁾ and it shows that the anti-inflammatory drugs have corrected the decreased absorption capacity of intestine during inflammation. The increased body weight during the treatment of standard drug and the ethanol extract may be due to the restoration of the absorption capacity of the

intestine.

From the results observed in the current investigation, it may be concluded that the ethanol extract of *Premna serratifolia* Linn., wood at the dose of 300 mg/kg body weight displays a significant anti-arthritic activity which may due to the presence of phytoconstituents such as alkaloids, steroids, flavonoids, phenolic compounds and glycosides specifically iridoid glycosides. Several studies indicate that aforementioned phytoconstituents possess significant anti-arthritic activity^(23 - 25).

The study is further extended to identify and characterize the exact active phytoconstituents and to elucidate the exact mechanism of action, which is responsible for the observed significant anti-arthritic activity against adjuvant induced arthritis in rats.

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