Pharmacognostic Evaluation of Leaf and Stem Wood Extracts of Artocarpus hirsutus Lam.

Mahadeva Nayak¹, Ananthanarayanan Nagarajan¹∗, Muhammed Majeed¹,²

ABSTRACT

Introduction: Artocarpus hirsutus Lam., a plant known for its fruits, used as a traditional medicine to treat skin diseases including hydrocele, pimple, heal sores, cracks in the skin. Pharmacological studies on the bark, root, leaf and fruit extracts of this species support their significance as antioxidants, as well as their efficacy on diuretic, antibacterial, anti-fungal and antiulcer activity. Methods: The present study focused on microscopic study, phytochemical analysis, HPLC and HPTLC finger print evaluation of leaf and stem wood extracts. Results: Microscopic analysis demonstrates its characteristic parameters namely hairy trichomes, pearl glands, vascular bundles, epidermis and is expected to assist easy identification of the genus. Conclusion: The solvent system, chloroform:methanol (8:2) was found to be the best as TLC eluent to visualize all major components of this species. HPLC and HPTLC fingerprints not only confirm the presence of two major components, oxyresveratrol and artocarpin in stem wood extract, but also prove their absence in the leaf extract.

Key words: Artocarpus hirsutus Lam., Microscopy, Phytochemical analysis, HPTLC fingerprints, HPLC.

INTRODUCTION

The genus Artocarpus belongs to family Moraceae and consists of more than 50 species. The species are either evergreen or deciduous trees, found in India, southern China, Malaysia and the Solomon Islands. Fruits of specific Artocarpus species are edible such as jack fruit and bread fruit, whereas other species of this genus (notably, A. heterophyllus Lam., A. altilis (Parkinson) Fosberg, A. hirsutus Lam., A. lakoocha Roxb. and A. camansi) usually find broad application as traditional medicines for treating diseases like diabetes, diarrhoea, dermatitis, malarial fever, asthma, tapeworm infection and anaemia.¹ Studies on leaf extracts of A. lakoocha Roxb. clearly demonstrate its ability in protection against liver damage, lowering elevated blood pressure and managing the blood sugar.² Major components in the bark, leaves and heart woods of the genus Artocarpus were found to be flavonoids with isoprene side chains³⁴ possessing antioxidant, anti-inflammatory, anti-diabetic, tyrosinase and melanin inhibition properties.⁵–⁹ A. hirsutus commonly known as wild jack, is mainly distributed in South Western Ghats of Peninsular India.¹⁰ Like other species of the genus Artocarpus, A. hirsutus also acquires similar plant biographies. Notably, it’s leaves are used traditionally in treating burbores and hydrocele whereas the leaves, fruits and barks help to cure diarrhoea, skin disease and haemorrhage.¹¹ The paste of bark ash in coconut oil is used for Tinea curas (dhobi’s itch). Topical application of stem bark extract is found to be effective in healing sores, cracks and pimples,¹ whereas the fruit juice of A. hirsutus induces appetite and relives the pains of haemorrhage.¹² Studies on pylorus ligated rats demonstrates that the A. hirsutus stem bark extract reduces the gastric secretory volume, acidity and ulceration.¹³ Nutritional natural supplements are often superior to synthetic supplements as they have minimal adverse effects, even in use for longer period. However, despite the benefits, there is still a relatively low commercial demand for these supplements. This could be due to non-availability of authentic raw material; inferior quality of raw material supply as well as lack of reproducible analytical techniques on herbal research.¹⁴ These technical complications can be resolved by conducting pharmacognostic studies of the raw material, which includes organoleptic characters, macroscopic analysis, microscopic analysis and powder study, physicochemical analysis, phytochemical analysis, HPLC and HPTLC finger print analysis.¹⁵ Marker compounds of natural origin are mostly used for confirming the correct botanical identity of the respective starting material. It is difficult to identify the correct marker compound for all traditional medicines because of the presence of unidentified multiple active constituents. By using chromatographic fingerprints, the authentication and identification of herbal medicines can be accurately achieved even if...
the amount and/or concentration of the components are not same in different plant extracts. Consequently, the lack of reliable chromatographic fingerprints in the literature demonstrates the need to develop authentic techniques to reproduce pharmacologically active and chemically characteristic component of the herbal medicine.

The genus Artocarpus has been monographed by Jarrett. However, no pharmacognostic study has been reported on A. hirsutus except its stem bark by Dibinlal and Seethadevi. The present study is thus designed and executed in order to incorporate microscopic, phytochemical, HPLC and HPTLC fingerprint analysis of leaf and stem wood of A. hirsutus as an additional source of analytical techniques on this species.

MATERIALS AND METHODS

General experimental procedures

HPTLC finger printing studies were performed on CAMAG LINOMAT 5 using pre-coated TLC plates [10 x 10 cm, silica gel 60 F254 TLC plates (Merck, India)]. The images were captured by using photo-documentation chamber (CAMAG REPROSTAR 3). The HPLC analysis was performed with Shimadzu Lab Solution HPLC system using LC-20AD software. Morphological evaluation was carried out using Nikon eclipse Ci microscope and the photographic images were captured by using a digital Nikon camera DS-Ri 2 fixed with the microscope.

Collection of plant materials

Fresh matured leaves and stem wood (Figure 1A and 1B) were collected from Udupi district, Karnataka, India, by the author in January 2015 and authenticated by Dr. M.D. Rajanna (Professor, Botanical Garden, University of Agriculture Sciences, GKVK, Bangalore, India). The voucher specimens were deposited in the departmental herbarium and assigned the voucher numbers (RD/HU-AH/10 and 12).

Morphology

Fresh samples of leaf and stem wood were preserved in formalin-acetic acid-alcohol (40% formalin: 5 mL; 50% ethanol: 90 mL; glacial acetic acid: 5 mL). Transverse sections were taken by using razor blade and were stained with Toluidine Blue O 0.05% in benzoate buffer (0.25g of benzoic acid in 200 mL water pH 4.4). Washed with water, observed under bright field as well as the epifluorescence optics using Nikon eclipse Ci microscope and the photographic images were captured using a digital Nikon camera DS-Ri 2 fixed with the microscope. The images were processed on Image NIS elements BR.

Preparation of plant extract

The fresh leaves and stem wood materials were dried and pulverized to a coarse powder. The powdered materials were individually extracted with three volumes of ethanol at refluxing condition (65–70°C) for three hours. The ethanolic extracts were dried completely under vacuum and subjected to phytochemical analysis, high performance liquid chromatography (HPLC) and high performance thin layer chromatography (HPTLC) fingerprint analysis to identify the chemical nature of the secondary constituents present in it.

Phytochemical analysis

The preliminary phytochemical screening for sterols, triterpenoids, alkaloids, flavonoids, lactones, tannins, saponins and carbohydrates were carried out as described by Evans.

HPTLC fingerprinting analysis

HPTLC finger printing studies were performed following the methods of Wagner and Balat, and Harborne. Various concentrations of both leaf and stem wood extracts (1, 2.5, 5, 10 and 20 mg/mL) were prepared in HPLC grade methanol (SD Fine chemicals, India) filtered through Whatman filter paper No. 1 and were used as test solutions for HPTLC analysis. The test solutions (2.0 µL each) were then loaded on pre-coated TLC plates [10 x 10 cm, silica gel 60 F254 TLC plates (Merck, India) with aluminum sheet support] with band length of 6 mm using a CAMAG LINOMAT 5 Automatic Sample Spotter (Camag Muttenz, Switzerland) in duplicate. Similarly, another TLC plate (5 x 10 cm) was loaded with 2.0 µL each of ethanolic stem wood extract (concentration: 20 mg/mL), leaf extract (20 mg/mL), oxyresveratrol (1mg/mL) and artoocarpin (1 mg/mL). All loaded TLC plates were placed in twin trough glass chamber saturated with mobile phase (chloroform: methanol, 8:2) for 20 minutes and eluted to a distance of 9 cm. The developed plate was positioned in the photo-documentation chamber (CAMAG REPROSTAR 3) and images were captured at 254 and 366 nm. Furthermore, these plates were scanned at 200 – 400 nm by using HPTLC Scanner 3. To visualize the spots, the developed plates were exposed to iodine vapours as well as sprayed with vanillin sulphuric acid reagent followed by drying at 100°C in hot air oven for 10 minutes. The images of vanillin sulphuric acid reagent treated plates were recorded in daylight and at 366 nm.

HPLC analysis

The HPLC analysis were performed with Shimadzu, LC-20AD, prominence using a BDS Hypersil C18 (Thermo), 250 x 4.6 cm, 5 µm column and mobile phase A: 0.05% acetic acid in water; B: 100% acetonitrile. The gradient program is depicted in box 1.

Box 1. Gradient program

<table>
<thead>
<tr>
<th>Time</th>
<th>B (concentration %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
</tr>
</tbody>
</table>

Total flow rate: 1.0 mL/min; detector: PDA at 254 nm; injection volume: 20 µL; run time: 30 min; diluent: methanol (HPLC grade)

Sample solutions: Dissolved 100 mg each of the ethanolic leaf and stem wood extracts with 25 mL of diluents in 50 mL volumetric flasks. After sonication for 15 minutes the volume was adjusted up to 50 mL with diluent and then filtered through Whatman No. 42 (ash less, diameter 125 mm, Cat. No. 1442-125).

Standard solutions: oxyresveratrol and artoocarpin solutions were prepared with diluents at concentration of 0.1 mg/mL.

RESULTS AND DISCUSSION

Microscopic Characters

Leaf

Leaf lamina is dorsiventral and the upper epidermis is mucilaginous. A few hairy trichomes are present near the midrib region. Occasionally, the outer cuticle envelope is interrupted by hyathode openings. The mesophyll cells are entirely of palisade parenchyma (2-4 cells thick) type and filled with numerous chloroplasts. It forms a complete network of cells with several secretory glands, called pearl glands, which is a significant feature of the leaf lamina surrounded by narrow bridges that contains vascular bundles. The upper epidermis is single layer thickness consisting of cystoliths here and there with calcified cell walls. The hairy trichome present in the lower epidermis consists of solitary prismatic calcium carbonate crystals at its base. The midrib contains 8-10 vascular
bundles. Vascular bundle is amphicribal type i.e. xylem surrounded by phloem. A sclerenchymatous cap surrounds bundle on the upper epidermal side (Figures 2A-F and 3A-D).

**Stem Wood**

The stem wood is brown to light black in colour, diffuse-porous, with solitary pores (occasionally grouped with two or three) and distinct growth rings. Tylose formation occurs in vessels in the matured wood. Vessel elements are simple perforation plates. Intervessel pits are alternate. The medullary rays are 2-3 cells thick. Ray cells are procumbent with one row of upright or squared marginal cells, axial parenchyma cells are paratracheal (Figure 4A-B).

**Phytochemical analysis**

The preliminary phytochemical analysis (Table 1) of extracts of leaf and stem wood revealed that the presence of sterols, terpenoids, flavonoids,

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**Figure 1A:** Habit of *A. hirsutus* Lam. 1B: Cross cut of the stem wood of *A. hirsutus* Lam

**Figure 2:** Transverse section of Leaf of *A. hirsutus*. A. The entire view of leaf stained with TBO (4x); B. Transverse section of leaf viewed under 10x enlarged view of midrib; C. Transverse section of leaf blade; D. Enlarged view of leaf blade viewed under 10x; E. Transverse section shows the complete network of cells with secretory cells; F. Presence of trichome in the lower epidermis layer of leaf blade.

**Figure 3:** Transverse section of the leaf viewed under UV. A. Leaf blade reflects the blue and red colour resembling the lignified cell wall and vascular bundles (blue) and chloroplast filled palisade parenchyma cells (red); B. Enlarged view of chemical content present in the leaf (arrowed); C. Midrib region fully lignified; D. Palisade parenchyma cells shows the presence of chloroplast and the leaf blade covered with the thin layered cuticle.

**Figure 4:** Transverse section of stem wood of *A. hirsutus*. A. Stem wood stained with TBO; B. A portion enlarged showing the vessel element, axial parenchyma cells, medullary rays.

**Figure 5:** HPTLC photo documentation of ethanolic extract of wood of *A. hirsutus*: A. at 254 nm and B. at 366 nm light. Where, Tracks 1 and 2: 1 mg/mL, Tracks 3 and 4: 2.5 mg/mL, Tracks 5 and 6: 5 mg/mL, Tracks 7 and 8: 10 mg/mL, Tracks 9 and 10: 20 mg/mL.
Table 1: Phytochemical studies of extracts of *A. hirsutus*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Phytochemicals</th>
<th>Test Name</th>
<th>Ethanolic extract of Leaf</th>
<th>Ethanolic extract of stem wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sterols</td>
<td>a. Salkowski test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. LB test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Triterpenoids</td>
<td>a. Salkowski test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. LB test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>Alkaloids</td>
<td>a. Mayers test</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Dragendorff test</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Wagners test</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Hagers test</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Flavonoids</td>
<td>a. Shinoda test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ferric chloride test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. lead acetate test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Lactones</td>
<td>a. Baljet test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Legal test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Fiegels test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>Tannins</td>
<td>a. Ferric chloride test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Gelatin test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>Saponins</td>
<td>a. Foam test</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>Carbohydrates</td>
<td>a. Molisch’s test</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Benedict’s test</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Where, “+” Positive and “−”: Negative

Table 2: *R*\(_f\) values of ethanolic extracts of *A. hirsutus*

<table>
<thead>
<tr>
<th>Sample</th>
<th>Visualization (R(_f) values)</th>
<th>Vanillin – sulphuric acid treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>@ 254 nm</td>
<td>@ 366 nm</td>
</tr>
<tr>
<td>Stem wood extract</td>
<td>0.1, 0.35, 0.4, 0.55, 0.65, 0.75</td>
<td>0.1, 0.15, 0.35, 0.38, 0.42, 0.5, 0.6, 0.65, 0.75</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>0.28, 0.58, 0.65</td>
<td>0.28, 0.3, 0.6, 0.65, 0.82, 0.88</td>
</tr>
</tbody>
</table>

Figure 6: HPTLC photo documentation of ethanolic extract of wood of *A. hirsutus* after A. Iodine vaporization; B. Vanillin sulphuric acid treatment recorded in visible light; C. Vanillin sulphuric acid treatment recorded at 366 nm light. Where, Tracks 1and 2: 1 mg/mL, Tracks 3 and 4: 2.5 mg/mL, Tracks 5 and 6: 5 mg/mL, Tracks 7 and 8: 10 mg/mL, Tracks 9 and 10: 20 mg/mL.
HPTLC of leaf extract

HPTLC finger print of ethanolic leaf extract displayed 4 spots (Figure 7A) with Rᵃ values of 0.28, 0.58, 0.63 and 0.82 when the TLC plate was analysed at 254 nm and the intensities of all spots were low. There were 8 spots observed when the TLC plate was visualized at 366 nm (Figure 7B). The spot having Rᵃ at 0.80 was found to be a major component at 366 nm, which was blue fluorescent in colour. The spot with Rᵃ at 0.88 when visualized in 366 nm was pink in colour and expected to be a triterpenoid. Five spots with yellow to yellowish brown colour were identified when the TLC plate was exposed to iodine vapours (Figure 8A). The intensity of the compound with Rᵃ at 0.65 was highest compared to the other compounds present in the extract. The intensity of the major compound (Rᵃ - 0.80) at 366 nm was diminished, similarly it was observed that on exposure to iodine vapours, its yellow colour disappears. When the TLC plate was treated with vanillin sulphuric acid and heated at 100 °C for 10 minutes, 6 compounds were detected at day light (Figure 6B). The spots with Rᵃ below 0.30 showed pink colour whereas Rᵃ at 0.60 and Rᵃ at 0.73 were yellow in colour. The spot with Rᵃ at 0.30 was found to be major compound. Interestingly when the same TLC plate was visualized under 366 nm (Figure 6C), the spots of Rᵃ of 0.60 and Rᵃ of 0.73 were illuminated with pale yellow and blue fluorescence respectively. The spots at Rᵃ of 0.30 and Rᵃ of 0.60 were found to be major compounds.

Comparison of HPTLC finger prints with standard compounds

Further the HPTLC finger prints (Figures 9A, 9B, 10A, 10B and 10C) of both stem wood and leaf extracts (20 mg/mL) were compared with two standard materials notably oxyresveratrol and artocarpin. Oxyresveratrol is a stilbene derivative and found in species of the same genus, viz. A. lakoocha Roxb.; A. champlasha Roxb.; A. heterophyllus Lam.; A. gomezianus Wall. (7, 24-26). Oxyresveratrol spot was illuminated with bluish fluorescence at 366 nm. The spot with Rᵃ at 0.80 appeared as pink in colour with maximum intensity. Interestingly when the same TLC plate was visualized under 366 nm (Figure 8C), more than 10 spots with different colour intensities were detected. The spots having Rᵃ at 0.18 and Rᵃ at 0.23 were bluish fluorescent in colour. The spots with Rᵃ at 0.55 and Rᵃ at 0.60 were yellow and greenish yellow in colour respectively. The spots at Rᵃ of 0.80 and Rᵃ of 0.85 were pink in colour. The intensities of all these spots were same and could be isolated individually.

5.1 Oxypeucedanin and oxyresveratrol

Oxypeucedanin and oxyresveratrol spots were observed when the TLC plate was sprayed with iodine vapours (Figure 5A). The spot with Rᵃ at 0.88 was illuminated with bluish fluorescence at 366 nm and at 254 nm, which was blue fluorescent in colour. The spot with Rᵃ at 0.88 when visualized in 366 nm was pink in colour and expected to be a triterpenoid.

Oxyresveratrol spot was illuminated with bluish fluorescence at 366 nm and at 254 nm, which was blue fluorescent in colour. The spot with Rᵃ at 0.88 when visualized in 366 nm was pink in colour and expected to be a triterpenoid.
presence of 4 major peaks, with retention time (RT) at 11.206 (17.928%), 19.544 (52.368%) 20.197 and 20.592 (7.001%). However, the corresponding peaks for oxyresveratrol and artocarpin were not detected in the HPLC chromatogram. It further reconfirms with the HPTLC results and represents the absence of oxyresveratrol and artocarpin in the leaf extract.

**CONCLUSION**

Present study describes the micromorphology, phytochemical analysis, HPLC and HPTLC finger print analysis of the leaf and stem wood which are in use as the traditional medicine. Determination of cell structural organisation and analysis of the tissues system are some of the pharmacognostic properties that are important for identifying the correct species of the plant and for distinguishing between closely related species of the same genus. The leaf shows the distinct network of mesophyll cells with the pearl glands and the palisade parenchyma cells possessing 2 to 4 cells thick with several chloroplasts. The axial parenchyma cells of stem wood are paratracheal and vessels are filled with tylose and vessels elements show the pits with simple perforation plates.

The preliminary phytochemical analysis of ethanolic extracts of leaf and stem wood of *A. hirsutus* showed that the presence of various secondary metabolites like sterols, terpenoids, flavonoids, lactones, tannins and saponins. The mobile phase, chloroform: methanol (8:2) was found to be superior solvent system for HPTLC and the plates were displayed with maximum separation of the components having distinct R values. This solvent system can be used during the isolation of constituents from both extracts. HPTLC finger prints of stem wood extract demonstrated the presence of oxyresveratrol and artocarpin, whereas they were absent in leaf extract and it was further confirmed by HPLC analysis. Hence the stem wood extract cannot be replaced with leaf extract for commercial purpose.

In conclusion, the micromorphological parameters, HPLC and HPTLC finger prints presented in this report can be used as diagnostic tools for the correct identification of the raw material of similar species, as well as to distinguish the admixture of known/unknown material and to check the quality of the raw material. Both oxyresveratrol and artocarpin could be used as reference compounds for standardization of the stem wood extract of *A. hirsutus*.

**ACKNOWLEDGEMENT**

The author(s) thank to Dr. Ambar K. Choudhury, Dr. M. Kathiresh, Mr. Manoj Kumar Yadav, Mr. Kiran Kumar Vuppala, Mr. John Adams, Analytical R&D team of Sami Labs Limited for their valuable support.

**CONFLICTS OF INTEREST**

The authors disclose no conflict of interest.

**ABBREVIATIONS**

HPLC: High Performance Liquid Chromatography; HPTLC: High Performance Thin Layer Chromatography; TLC: Thin Layer Chromatography; PDA: Photo Diode Array; mL: Mili Litre; min: minute; nm: nanometer; No.: Number; LB Test: Liebermann–Burchard test; RT: Retention Time.

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**Figure 11:** HPLC chromatogram of ethanolic extract of stem wood *A. hirsutus*.

**Figure 12:** HPLC chromatogram of ethanolic extract of leaf *A. hirsutus*. 

at 100 °C for 10 minutes (Figure 10A; 27) whereas it was detected as purple in colour when it was visualized at 366 nm (Figure 10C). Artocarpin is a flavonoid and reported to be found in species of the same genus mainly *A. heterophyllus*, *A. incises*, *A. nitidus* and *A. hirsutus*.23,28-30 The HPTLC of artocarpin displayed as dark spot at 254 nm (Figure 9A) and navy blue spot at 366 nm (Figure 9B). The compound also appeared as yellow spot with vanillin sulphuric acid reagent when detected at visible light and at 366 nm (Figure 10A, 10C).

HPTLC finger print of ethanolic stem wood extract showed the presence of both oxyresveratrol as well as artocarpin as the major compounds. Whereas appearances of these compounds were absent in HPTLC finger prints of ethanolic leaf extract. The constituents of stem wood and the leaves were totally different and cannot be interchanged. Hence it is essential to isolate the actives from the leaf extract and explore their pharmacological benefits. Recently, it was reported by us that oxyresveratrol isolated from wood of *A. hirsutus* possessed promising anti-inflammatory, antioxidant and skin lightening properties.23

**HPLC analysis**

HPLC chromatogram of stem wood extract (Figure 11) represented the presence of 4 major peaks, with retention time (RT) at 11.206 (17.928%), 20.114 (4.001%), 23.092 (52.368%) and 25.180 (7.001%) minutes. Of these, the peak eluted at 23.092 min was found to be the major component and contains more than half of the total weight. The second highest peak was found with RT at 11.206 min. These two peaks corresponds with artocarpin (RT 23.040 min) and oxyresveratrol (RT, 11.004 min) respectively.

The HPLC chromatogram of leaf extract (Figure 12) showed the presence of 3 peaks with retention time (RT) at 7.533 (10.849%), 9.910 (11.874%), 19.544 (52.368%) 20.197 and 20.592 (7.001%). However, the corresponding peaks for oxyresveratrol and artocarpin were not detected in the HPLC chromatogram. It further reconfirms with the HPTLC results and represents the absence of oxyresveratrol and artocarpin in the leaf extract.
REFERENCES


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Mr. Mahadeva Nayak, Research scholar, has been with Sami Labs Limited since 2002 in R&D centre as a Scientist and since 2008 he holds the position of Manager – Technical Marketing, which primarily works as an interface between R&D, Product and Business Development. He obtained his Graduation degree in Pharmacy from College of Pharmaceutical Sciences, Manipal, affiliated to Mangalore University and Masters degree in Pharmacy (M. Pharm) from Government College of Pharmacy, Bangalore, affiliated to Rajiv Gandhi University of Health Sciences, Bangalore. He has published more than 5 articles in reputed journals and co-author in 2 books.

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