

Review Article

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## A REVIEW ON *PUNARNAVA* – *BOERHAAVIA DIFFUSA* LINN.

\*Divya Raj<sup>1</sup>, P. Y. Ansary<sup>2</sup>, Sara Moncy Ommen<sup>3</sup>, Shincymol V.V.<sup>4</sup>

<sup>1</sup>PG Scholar, Department of Dravyagunavijnanam Government Ayurveda College, Tripunithura, Ernakulam, Kerala, India.

<sup>2</sup>Professor & HOD, Department of Dravyagunavijnanam Government Ayurveda College, Tripunithura, Ernakulam, Kerala, India.

<sup>3</sup>Professor & HOD, Department of Dravyagunavijnanam Government Ayurveda College, Kannur, Paryaram, Kerala, India.

<sup>4</sup>Associate Professor, Department of Dravyagunavijnanam Government Ayurveda College, Tripunithura, Ernakulam, Kerala, India.

Corresponding Author's Email ID: [divya.raj9500@gmail.com](mailto:divya.raj9500@gmail.com)

### Abstract

*Punarnava* is a commonly used medicinal plant and it has high therapeutic value. It is botanically identified as *Boerhaavia diffusa* Linn. The utilization of the medicinal properties of the drug *Punarnava* started from the Vedic period itself. Later it was widely used in *Samhitha* period and *Nighantu* period. Synonyms, therapeutic properties and uses are mentioned elaborately in *Nighantus*. The administration method of the drug *Punarnava* explained as both internally and externally. The various uses of the drug *Punarnava* are also mentioned in the regional textbooks like *Chikita Manjari*, *Vaidya Manorama* etc. It acts on the various systems of the body. *Boerhaavia diffusa* Linn. belongs to the family Nyctaginaceae is a creeping herb which spreads on the ground. The root and whole plant are used for the medicinal purposes. It is known as thazhuthama in Kerala. Various pharmacological and phytochemical evaluations were conducted by different scholars. Alkaloids, flavonoids, phenolic compounds etc. were isolated from the root of *Boerhaavia diffusa* Linn.

**Key word:** *Punarnava*, *Boerhaavia diffusa* Linn., pharmacognosy, phytochemistry, pharmacology

## INTRODUCTION

The sanskrit word *Punarnava* can be literally translated as renewer of body. It revitalises the entire body, as its name implies.<sup>1</sup> The medicinal plant which is mentioned as *Punarnava* in Ayurvedic classics is a creeper that grows untamed in Kerala. *Punarnava* was first illustrated and discussed in *Atharva veda*.<sup>2</sup> Information's regarding the use of the root were mentioned in *Ashtanga Hridaya*.<sup>3</sup> Synonyms appertaining to the identification of the drug, its *rasadi panchaka* (pharmacological properties), *karma* (actions) and *rogaghnata* (therapeutic indications) of the drug are available in *Nighantus*.<sup>4</sup> The internal administration of root of *Punarnava* as simple form is mentioned in Malayalam textbooks like *Chikitsa Manjari*, *Vaidya Manorama* and *Sarvaroga Chikitsa Rathnam*.<sup>5,6,7</sup>

## MATERIALS AND METHODS

Literary research was done by referring Ayurvedic classics, various journals and internet sources.

## RESULTS AND DISCUSSION

### I. Historical background

#### A. Vedic period

The drug *Punarnava* is mentioned in *Atharvaveda* with its therapeutic indications are explained both internally and externally. The drug is mentioned as *agni deepaka* (increases digestive fire), *pachaka* (that which digests), *mootrala* (increases urine) and *kapha nissaraka* (removes excess *kapha*). Internal administration of the drug is mentioned in diseases like *pandu* (anaemia), *sotha* (oedema), *kamala* (jaundice) and *mootrakrichra* (dysuria). Also, it is mentioned for external application in *keeta visha damsa* (insect bite).<sup>2</sup>

#### B. Samhita period

The drug *Punarnava* has been described in *Samhitas* including *Charaka Samhita*, *Susruta Samhita*, *Ashtanga Sangraha* and *Ashtanga Hridaya*. The useful parts like root and leaf are mentioned in various context in *Samhithas*. *Charaka Samhitha* and *Ashtanga Sangraha* mentioned about *Punarnava* while mentioning the *ganas* like *swedopaga*, *anuvasanopaga*, *kasahara*, *madhura skandhas* and *ushna veerya dravyas*.<sup>8,9,10,11,12</sup> Acharya Susruta and Vagbhata included *Punarnava* under various *vargas* like *Shaka varga* etc.<sup>13,14</sup>

#### C. Nighantu Period

The drug *Punarnava* is extensively described along with its synonyms, properties and uses in various *Nighantus* under specific *vargas*. The indication of *Punarnava* in *vikaras* (diseases) affecting the *rakthavaha srotas* is specifically mentioned in *Raja Nighantu*.<sup>15</sup> Its therapeutic indications in *pandu* (anemia) is also mentioned in *Nighantus*.<sup>16,17,18</sup> *Priya*

*Nighantu* indicated the drug *Punarnava* in *kamala* (jaundice).<sup>4</sup> Its *matra* (dose) of one *tola* (12 gm) is mentioned in *Nighantu Adarsha*.<sup>19</sup>

This plant is very much popular among traditional Ayurvedic physicians. In *Chikitsa Manjari*, *Punarnava moola kalka* (root paste of *Boerhaavia diffusa* Linn.) with *Nalikerodaka* (tender coconut water) is mentioned in *kamala* (jaundice) which is one among the important *yakrt vikaras* (liver disorders).<sup>5</sup> This is also mentioned in textbooks like *Vaidya Manorama* and *Sarvaroga Chikitsa Rathnam*.<sup>6,7</sup>

In The Ayurvedic Pharmacopoeia of India, it is mentioned that *Punarnava* is useful in *yakrt roga* (liver disorders).<sup>20</sup>

## II. *Vargeekarana* (Classification) of *Punarnava*

The drug *Punarnava* is enlisted under various *vargas* and *ganas* in *Samhitas* and *Nighantus*. This classification is done mainly based on its pharmacological and therapeutic activities.

**Table No:1 *Vargeekarana* (Classification) of *Punarnava***

Sl. No.	Name of the text	<i>Skanda/ Varga/ Gana</i>
1.	<i>Caraka Samhita</i>	<i>Swedopaga varga</i> , <sup>8</sup> <i>Anuvasanopaga varga</i> , <sup>9</sup> <i>Kasahara varga</i> , <sup>10</sup> <i>Vayasthapana varga</i> , <sup>21</sup> <i>Vamana dravya</i> , <sup>22</sup> <i>Madhura skandha</i> , <sup>11</sup> <i>Tiktha skandha</i> , <sup>23</sup> <i>Saka varga</i> , <sup>24</sup> <i>Virechana kalpa</i> , <sup>25</sup> <i>Ushna veerya dravya</i> <sup>12</sup>
2.	<i>Susruta Samhita</i>	<i>Vidaarigandhadi gana</i> , <sup>26</sup> <i>Vata samshamana varga</i> , <sup>27</sup> <i>Tikta varga</i> , <sup>28</sup> <i>Shaka varga</i> <sup>13</sup>
3.	<i>Ashtanga Sangraha</i>	<i>Kasahara mahakashaya</i> , <sup>29</sup> <i>Vayasthapana mahakashaya</i> , <sup>30</sup> <i>Vidaryadi gana</i> , <sup>31</sup> <i>Vamanopayogi gana</i> , <sup>32</sup> <i>Virechanopayogi gana</i> , <sup>33</sup> <i>Niroohopayogi gana</i> , <sup>34</sup> <i>Swedopaga gana</i> <sup>35</sup>
4.	<i>Ashtanga Hridaya</i>	<i>Madhyama panchamoola</i> , <sup>36</sup> <i>Vidaryadi gana</i> , <sup>37</sup> <i>Saka varga</i> <sup>14</sup>
5.	<i>Dhanwantari Nighantu</i>	<i>Guduchyaadi varga</i> <sup>16</sup>
6.	<i>Madanadi Nighantu</i>	<i>Vidaryadi gana</i> <sup>38</sup>
7.	<i>Sodhala Nighantu</i>	<i>Guduchyaadi varga</i> <sup>39</sup>
8.	<i>Madanapala Nighantu</i>	<i>Abhayadi varga</i> <sup>40</sup>
9.	<i>Kaiyyadeva Nighantu</i>	<i>Aushadhi varga</i> <sup>17</sup>
10.	<i>Raja Nighantu</i>	<i>Parpatadi varga</i> <sup>15</sup>
11.	<i>Bhavaprakasa Nighantu</i>	<i>Guduchyadi varga</i> <sup>18</sup>
12.	<i>Saraswati Nighantu</i>	<i>Ulapadi varga</i> <sup>41</sup>
13.	<i>Rajavallabha Nighantu</i>	<i>Saka varga</i> <sup>42</sup>
14.	<i>Nighantu Adarsha</i>	<i>Punarnavadi varga</i> <sup>19</sup>

15.	<i>Ayurveda Chinthamani</i>	<i>Guduchyadi varga</i> <sup>43</sup>
16.	<i>Abhidhana Manjari</i>	<i>Vidaryadi gana</i> <sup>44</sup>
17.	<i>Hridaya Dipaka Nighantu</i>	<i>Dvipadi varga</i> <sup>45</sup>
18.	<i>Priya Nighantu</i>	<i>Shatapushpadi varga</i> <sup>46</sup>

### III. Paryayas (Synonyms) and Interpretations of *Punarnava*

*Nighantus* mentioned synonyms of the drug *Punarnava* based on the habitat, morphology, properties and actions. The interpretations of its synonyms are available in *Amarakosha*,<sup>47</sup> *Namarupa Vijnanam*<sup>48</sup> and *Shabdakalpadruma*.<sup>49</sup>

#### A. Based on morphological Characters of *Punarnava*

##### a. Habitat

**Table No: 2 Paryayas (Synonyms) of *Punarnava* based on Habitat**

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	Hri.D <sup>45</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Punarnava</i>	+	+	+	+	+	+			+		+
<i>Kshudra varshabhoo</i>	+		+							+	+
<i>Varshabhoo</i>		+			+	+			+	+	
<i>Varshaketu</i>		+							+		
<i>Pravrushyani</i>										+	

- *Punarnava*: It is based on two aspects. First one based on the peculiarity of the plant like it regenerates repeatedly after cutting. It can also interpret as a good rejuvenating agent.
- *Pravrishyane, Varshabhoo, Varshaketu*: Which sprout again in the rainy season.
- *Kshudra varshabhoo*: Plant sprout with light raining.

##### b. Habit

**Table No: 3 Paryayas (Synonyms) of *Punarnava* based on Habit**

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	Hri.D <sup>45</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Kathilla</i>	+						+				
<i>Visakha</i>	+		+			+					
<i>Punarbhoo</i>					+	+					

- *Kathilla*: A creeper that spreads in all directions.

- *Visakha*: With extensive branches or spreads well in all directions.
- *Punarbhoo*: It denotes the ability of the plant to sprout again.

### c. *Moola* (root)

**Table No: 4 Paryayas (Synonyms) of *Punarnava* based on morphological Characters of root**

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Swethamoola</i>		+		+	+		+	+	+	

- *Swetha moola*: With white roots

### d. *Patra* (leaf)

- *Mandalapatra*: Plant with round leaves.
- *Kshudrapatra*: Plant with small leaves
- *Deerghapatra*: Plant with long leaves
- *Raktha patra*: With reddish leaves
- *Swetha patra*: With white leaves

**Table No: 5 Paryayas (Synonyms) of *Punarnava* based on morphological Characters of leaf**

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Deerghapatra</i>	+		+	+	+	+	+	+		
<i>Mandalapatra</i>		+			+					
<i>Kshudra patra</i>		+								
<i>Rakthapatra</i>					+					
<i>Swetha patra</i>								+		
<i>Raktha pushpa</i>									+	

e. *Pushpa* (flower)Table No: 6 *Paryayas* (Synonyms) of *Punarnava* based on morphological Characters of flower

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Raktha pushpa</i>									+	+	

- *Raktha pushpa*: With red flower.

B. Based on Pharmacological actions of *Punarnava*Table No: 7 *Paryayas* (Synonyms) of *Punarnava* based on Pharmacological actions

Synonyms	D.N <sup>16</sup>	Ma. N <sup>38</sup>	So. N <sup>39</sup>	M.P <sup>40</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	Bp. N <sup>18</sup>	Sa. N <sup>41</sup>	Ni. A <sup>19</sup>	Ab.M <sup>44</sup>
<i>Kadillaka</i>	+		+			+			+	+
<i>Sivadika</i>	+									
<i>Sothaghni</i>					+		+	+		

- *Kadillaka*: It is a useful drug
- *Sivadika*: It is a useful drug
- *Sothaghni*: Which is beneficial in oedema.

IV. *Rasa panchaka* (Pharmacological properties) of *Punarnava*

Acharya Charaka and Susruta explained the drug *Punarnava* under *tiktha varga*.<sup>23,28</sup> Majority of authors of *Nighantu* opined that the *rasa* (taste) of *Punarnava* is *tiktha* (bitter taste). Whereas *Bhavaprakasa* mentions *katu* (pungent) and *kashaya rasa* (astringent taste). *Kaiyyadeva Nighantu* specially mentioned *kshara* (alkaline) as *anurasa* (secondary taste).<sup>16</sup> *Ruksha guna* (dryness) of the drug is being highlighted in most of the *Nighantus*. The *veerya* (potency) of the drug is opined to be *ushna* (hotness) by all authors of Ayurvedic lexicons. *Madanapala Nighantu* coins the *vipaka* (post-digestive state) as *katu* (pungent).<sup>40</sup> But in The Ayurvedic Pharmacopoeia of India, *vipaka* is mentioned as *Madhura* (sweet).<sup>20</sup>

**Table No:8 Rasa panchaka (Pharmacological properties) of Punarnava**

<i>Samhitas &amp; Nighantus</i>	<i>Rasa</i>	<i>Guna</i>	<i>Veerya</i>	<i>Vipaka</i>
<i>Dhanwantari Nighantu</i> <sup>16</sup>	<i>Tiktha</i> (bitter)	<i>Ruksha</i> (dryness)	<i>Ushna</i> (hot)	-
<i>Madanapala Nighantu</i> <sup>40</sup>	<i>Tiktha</i> (bitter)	<i>Ruksha</i> (dryness)	<i>Ushna</i> (hot)	<i>Katu</i> (pungent)
<i>Kaiyyadeva Nighantu</i> <sup>17</sup>	<i>Madhura</i> (sweet), <i>Tiktha</i> (bitter), <i>Kashaya</i> (astringent), <i>Katu</i> (pungent) <i>Anurasa-Kshara</i> (alkaline)	<i>Ruksha</i> (dryness)	<i>Ushna</i> (hot)	-
<i>Raja Nighantu</i> <sup>15</sup>	<i>Tiktha</i> (bitter)	-	<i>Ushna</i> (hot)	-
<i>Bhavaprakasa Nighantu</i> <sup>18</sup>	<i>Katu</i> (pungent), <i>Kashaya</i> (astringent)	-	-	-
The Ayurvedic Pharmacopoeia of India <sup>20</sup>	<i>Madhura</i> (sweet), <i>Tiktha</i> (bitter), <i>Kashaya</i> (astringent)	<i>Laghu</i> (lightness), <i>Ruksha</i> (dryness) <i>Sara</i> (mobility)	<i>Ushna</i> (hot)	<i>Madhura</i> (sweet)

**V. Karma (Pharmacological actions) of Punarnava**

*Nighantus* provide basic information regarding actions of *Punarnava* on *doshas* (regulatory functional factors of the body), *dhatu*s (fundamental structural component), *agni* (digestive fire), *avayava* (a body part or organ) and *indriya* (cognitive organ).

**Table No:9 Karma (Pharmacological actions) of Punarnava**

Action on <i>Doshas</i> (regulatory functional factors of the body)	<i>Anila kaphapaha</i> (pacify <i>vata</i> and <i>kapha</i> ), <sup>17,18,20</sup> <i>Kaphapaha</i> (pacify <i>kapha</i> ) <sup>15,16</sup>
Action on <i>Dhatu</i> s (fundamental structural component)	<i>Asra roga</i> (diseases pertaining to blood) <sup>17</sup>
Action of <i>Agni</i> (digestive fire)	<i>Deepana</i> (stimulate digestive fire) <sup>17,18</sup>

Action on <i>Avayava</i> (a body part or organ)	<i>Hridya</i> (substance enhancing health and functioning of the heart) <sup>17</sup>
Action on <i>indriya</i> (cognitive organ)	<i>Ruchya</i> (taste enhancer) <sup>17</sup>

## VI. Rogagnatha (Therapeutic indications) of *Punarnava*

*Punarnava* has been mentioned in the treatment of diseases affecting *srotases* like *pranavaha*, *annavaha*, *udakavaha*, *rasavaha*, *rakthavaha*, *mamsavaha*, *asthivaha* and *mootavaha*. The opinions are tabulated below.

**Table No:10 Rogagnatha (Therapeutic indications) of *Punarnava***

Indications	D.N <sup>16</sup>	Ka. N <sup>17</sup>	Ra. N <sup>15</sup>	B. P <sup>18</sup>	API <sup>20</sup>
<b><i>Pranavaha srotas</i></b>					
<i>Kasa</i> (cough)		+	+		+
<i>Gara</i> (poison)		+			
<i>Hridroga</i> (cardiac disorders)	+		+	+	+
<b><i>Annavaha srotas</i></b>					
<i>Soola</i> (abdominal colic)	+		+		+
<i>Agnimandhya</i> (decreased digestive fire)					+
<b><i>Udakavaha srotas</i></b>					
<i>Udara</i> (ascites)		+		+	+
<b><i>Rasavaha srotas</i></b>					
<i>Jwara</i> (fever)					+
<i>Pandu</i> (anaemia)	+	+	+		
<b><i>Raktavaha srotas</i></b>					
<i>Sopha</i> (oedema)	+	+	+	+	+
<i>Gulma</i> (abdominal tumor)					+
<i>Yakrt roga</i> (liver disorders)					+
<i>Pleeha roga</i> (splenic disorders)					+
<i>Rakthavikara</i> (disorders pertaining to blood)			+		
<b><i>Mamsavaha srotas</i></b>					
<i>Arsas</i> (haemorrhoids)		+			+
<b><i>Asthivaha srotas</i></b>					
<i>Vata janya vikara</i> (disorders of <i>vata</i> )			+		
<b><i>Mootraavaha srotas</i></b>					
<i>Vasthi soola</i> (pain in urinary bladder)					+
<i>Bradhna</i> (enlargement of scrotum)				+	
<b><i>Sthanika roga</i></b>					
<i>Vrana</i> (wounds)		+			+



## VII. *Prayojya anga* (Useful parts) of *Punarnava*

The useful parts are described as follows.

*Mula* (Root)<sup>5,6,7,19,20</sup>

*Patra* (Leaf)<sup>19</sup>

*Panchanga* (Whole plant)<sup>19</sup>

## VIII. *Matra* (Dosage) of *Punarnava*

The dose required for internal administration in varied dosage forms are given in various Ayurvedic lexicons.

As *rasayana* –  $\frac{1}{2}$  *karsha*<sup>3</sup>

Based on formulations - *Kwatha* (decoction) - 20-30 gm of the drug for decoction<sup>20</sup>

Based on useful parts - *Moola, Panchanga* - 1-2 *tola* (12 – 24 gm)<sup>19</sup>

Based on administration in diseases - *jalodara* and *sotha* -  $\frac{1}{4}$  -  $\frac{1}{2}$  *tola* (3-6 gm)<sup>19</sup>

## IX. *Amayika prayoga* (Therapeutic uses) of *Punarnava* in *kamala* (jaundice)

### A. Single drug administration

In *Chikitsa Manjari*, *Vaidya Manorama* and *Sarvaroga Chikitsa Rathnam* the use of *Punarnava moola kalka* (root paste of *Boerhaavia diffusa* Linn.) with *Nalikerodaka* (tender coconut water) as *anupana* (vehicle) is mentioned as one of the best medicines in *kamala* (jaundice).<sup>5,6,7</sup>

### B. Polyherbal Formulations

#### a. *Kashaya kalpana*

*Kashaya* prepared with *Punarnava* along with other drugs like *bala* (*Sida cordifolia*), *Bhadra* (*Aerva lanata* (L.) Juss. ex Schult.), *madanakhanda* (*Spermacoce hispida* L.) is useful in *kamala* (jaundice).<sup>50</sup>

#### b. *Vadaka kalpana*

The main indications of *Punarnavadi mandura* is *kamala* (jaundice) and *haleemaka*.<sup>51</sup>

#### c. *Leha kalpana*

*Punarnavadi leham* is mentioned as the formulation which is useful in *kamala* (jaundice).<sup>52</sup>

## X. Botanical identity

The plant has been detailed as *Boerhaavia diffusa* Linn. in 'The Indian Medicinal plants' by Kirtikar K R and Basu B D,<sup>53</sup> 'Flora of the presidency of Madras',<sup>54</sup> 'Indian Medicinal Plants -A compendium of 500 species',<sup>55</sup> 'Ayurvedic Drugs and their Plant sources by V.V Sivarajan',<sup>56</sup> 'The wealth of India'.<sup>57</sup>

**Botanical name** : *Boerhaavia diffusa* Linn.

**Botanical synonyms**<sup>56</sup> : *Boerhaavia repens* Linn.

*Boerhaavia procumbens* Roxb.

*Boerhaavia erecta*

**Family** : Nyctaginaceae

### Systemic position:

Kingdom – Plantae

Class – Dicotyledons

Subclass – Monochlamydeae

Series – Curvembryeae

Family – Nyctaginaceae

Genus – *Boerhaavia*

Species - *diffusa*

### Vernacular names

Vernacular names of the plant *Boerhaavia diffusa* Linn. are enlisted in The Indian Medicinal Plants -A compendium of 500 species,<sup>55</sup> The wealth of India,<sup>57</sup> Pharmacognosy of Ayurvedic Drugs of Travancore Cochin,<sup>58</sup> Quality standards of Indian medicinal plants,<sup>59</sup> and The Ayurvedic Pharmacopoeia of India.<sup>20</sup>

Sanskrit : *Kathilla, Sophaghni, Sothaghni, Varshabhu*

English : Horse Purslane, spreading hog weed

Hindi : *Gadapurna, Lalpunarnava, Bheshakapore, Tikri*

Malayalam : *Tazhutawa*

Tamil : *Mukurattai (Shihappu), Tamizhamai, Thazhuthamai*

Bengali : *Rakta punarnava*

Telugu	: <i>Atikamamidi, Erra galijeru</i>
Gujarati	: <i>Dholisaturdi, Motosatodo</i>
Kannada	: <i>Sanadika, Kommeberu, Komma</i>
Marathi	: <i>Ghetuli, Vasuchimuli, Satodimula, Punarnava, Khaparkhuti</i>
Punjabi	: <i>Itcit (Ial), Khattan</i>
Oriya	: <i>Lalapuiruni, Nalipuruni</i>

## **XI. Taxonomy of the plant *Boerhaavia diffusa* Linn.**

The detailed description of taxonomy of the plant *Boerhaavia diffusa* Linn. is found in The Ayurvedic Pharmacopoeia of India,<sup>20</sup> Quality standards of Indian medicinal plants,<sup>59</sup> The Indian Medicinal plants,<sup>53</sup> Pharmacognosy of Ayurvedic Drugs of Travancore cochin,<sup>58</sup> Indian Medicinal Plants -A compendium of 500 species,<sup>55</sup> The wealth of India<sup>57</sup> and Ayurvedic Drugs and their Plant sources.<sup>56</sup>

**Distribution and habitat:** The plant is found all over India from Punjab to Assam in the north ascending to about 7000 feet in the Himalayan valleys and southward to Coromandel coast and Kerala as far as Kanyakumari. It is especially abundant during the rainy season.

**Habit:** A diffusely branched low spreading or creeping herbaceous perennial plant.

**Root:** Taproot, elongate, narrowly fusiform or tapering, slightly tuberous but not very stout. It grows vertically downwards and penetrates so deep into the soil. It is cream or light brownish yellow externally and has a soft skin. The surface of old root is often marked with knotty scars of fallen rootlets.

**Stem:** Branched, spreading on the ground, longitudinally striated, nodes swollen, greenish purple, glabrous on complete maturation. Fracture tough and short, fractured surface hollow in the centre.

**Leaves** : Simple, opposite, petiolate, petiole is nearly as long as lamina, thick, ovate to orbicular, variable in size, 2 to 4 cm in length, 1.5 to 3 cm in width, rounded at apex, rounded to sub-cordate at base, undulated margin, upper surface green, lower surface silvery white.

**Inflorescence:** Long peduncled axillary and terminal umbels.

**Flowers:** Very small, bracteate.

**Androecium:** Stamens 2 or 3 slightly exerted arising from the base and connate around the ovary; anthers - minute, round di-dynamous and two-celled.

**Gynoecium:** Ovary small, stipitate, nearly completely enclosed by the basal half of the perianth, oblique, acute and unilocular with one erect basal ovule, style slender, equalizing the stamens and ending in an obtuse peltate stigma.

**Fruits :** One seeded nut, 6 mm long clavate, rounded, broadly and bluntly 5 ribbed, viscidly glandular.

**Seeds:** Adherent testa, embryo curved, cotyledon thin, broad, the outer one being large, encloses soft scanty floury albumen, radical long.



**Picture No:1 *Boerhaavia diffusa* Linn.**

## **XII. Pharmacognostical evaluation of root of *Boerhaavia diffusa* Linn.**

### **A. Macroscopy**

The macroscopy of fresh root of *Boerhaavia diffusa* Linn. has been described in Pharmacognosy of Ayurvedic drugs of Travancore-Cochin<sup>58</sup> and of dried root in The Ayurvedic Pharmacopoeia of India Vol 1.<sup>20</sup>

#### **a. Root**

Macroscopic features of the fresh and dried root of the plant, that include shape, size, colour, external surface, cut surface, fracture, odour and taste are tabulated below.<sup>20,58,60,61</sup>

**Table 11: Macroscopic features of root of *Boerhaavia diffusa* Linn.**

<b>Observations</b>	<b>Fresh root</b>	<b>Dried root</b>
Shape	Long, somewhat tuberous, cylindrical to narrowly fusiform to conical or tapering.	Cylindrical, somewhat tortuous.
Size	0.2–1.5 cm in diameter.	0.5 to 1.5 cm thick.
Colour	Light yellow brown to brownish grey colour.	Light yellow brown to brownish grey.

External surface	Turgid, surface skin is soft and smooth though appearing minutely transversely striated or pitted. Occasionally with lateral roots near its distal end.	Outer surface soft to touch but rough due to minute longitudinal striations and root scars.
Cut surface	Just within outer layer there is a thin yellowish-brown layer which can also be scraped easily. Inside these layers bright silvery or chalk white region which in tangential section appears to be made up of a very large number of minute narrowly elliptical white spots. This gives the region its characteristic lusture. Centre portion is fairly wide with woody core.	Shows thin bark, yellowish white cortical region and a central woody portion.
Fracture	Short	Fibrous
Odour	No distinct odour	No distinct odour
Taste	Slightly bitter, sweet, pungent	Slightly bitter

### b. Root powder

Details regarding macroscopic features of the root powder of *Boerhaavia diffusa* Linn. have been described by Nishi Saxena et.al.<sup>62</sup>

**Table No 12: Powder Macroscopic features of root of *Boerhaavia diffusa* Linn.**

Observations	Root powder
Colour	Light brown
Odour	Characteristic
Taste	Bitter

### B. Microscopy

Details regarding microscopic features of the fresh root of *Boerhaavia diffusa* Linn. have been described in Quality standards of Indian medicinal plants,<sup>59</sup> Pharmacognosy of Ayurvedic drugs of Travancore-Cochin,<sup>58</sup> The Ayurvedic Pharmacopoeia of India<sup>20</sup> and by Somenath Gosh et.al and Vijeta Gupta et.al.<sup>60,61</sup>

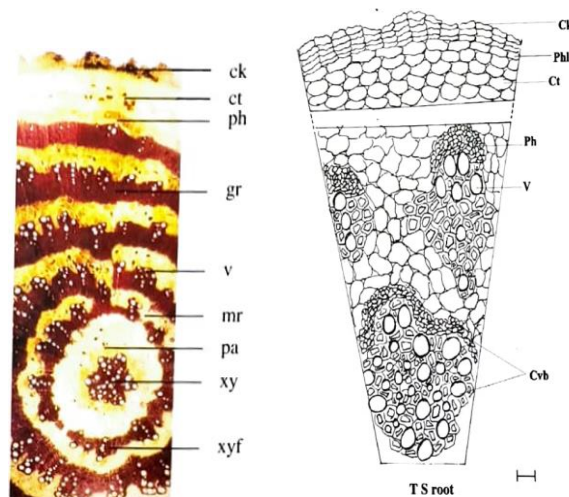
## a. Root

**Periderm** - Transverse section of mature root shows a cork composed of thin-walled tangentially elongated cells with brown walls in the outer few layers, cork cambium of 1-2 layers of thin-walled cells.

**Cortex** - Composed of 5-12 layers of thin-walled, oval to polygonal cells, several concentric bands of xylem tissue alternating with wide zone of parenchymatous tissue are present below cortical regions, number of bands vary according to thickness of root and are composed of vessels, tracheids and fibres. Vessels mostly found in groups of 2-8 in radial rows, having simple pits and reticulate thickening. Tracheids are small, thick walled with simple pits. Fibres are aseptate, elongated, thick-walled, spindle shaped with pointed ends.

**Vascular strands** – Xylem consists of widely separated radial groups or rows of vessels. Phloem does not surround the xylem. But occurs in the form of crescent shaped patches first outside the group of xylem vessels in the ring of wood. In mature roots, three or more concentric rings of the vascular strands found outside the central vascular zone.

**Central vascular zone** - Central regions of root are occupied by primary vascular bundles. Numerous raphides of calcium oxalate are present in single or in group in cortical region. In between xylem tissue parenchymatous cells are present. Starch grains that are simple and compound having 2-4 components are found in abundance in most of cells of cortex.



**Picture No: 2 Microscopy of root *Boerhaavia diffusa* Linn.<sup>58,59</sup>**

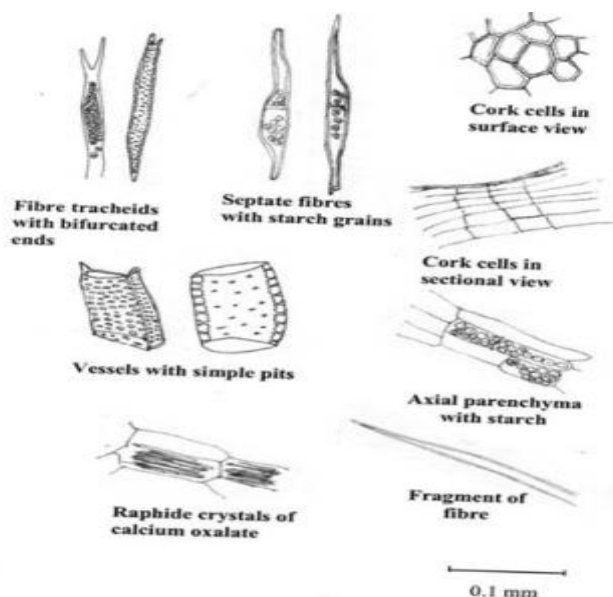
(ck - cork; ct – cortex; gr - growth ring; mr - medullary ray; pa - parenchyma; ph - phloem; v - vessel; xy - xylem; xyf - xylem fibre.) (Ck - cork; Ct - cortex; Phl - phellogen; Ph - phloem; V - vessel; Cvb - central vascular bundle)

## b. Powder microscopy of root

Details regarding the microscopy of root powder of *Boerhaavia diffusa* Linn. were

elaborated in The Ayurvedic pharmacopoeia of India.<sup>63</sup>

Light yellow coloured root powder shows vessels with reticulate thickening or simple pits, fibres, fragments of cork cells, cells containing raphides of calcium oxalate and starch grains.



**Picture No: 3 Powder microscopy of *Boerhaavia diffusa* Linn. root<sup>63</sup>**

### **XIII. Physicochemical evaluation of *Boerhaavia diffusa* Linn. root powder**

The physicochemical evaluation of the root of *Boerhaavia diffusa* Linn. has been described in The Ayurvedic Pharmacopoeia of India and Quality standards of Indian medicinal plants.<sup>20,59</sup> The permissible value of foreign matter, total ash, acid insoluble ash, alcohol soluble extractive and water-soluble extractive of dried root are available in The Ayurvedic Pharmacopoeia of India, in addition to this moisture content was described by Gupta AK et al.<sup>64</sup> Fibre content was described by Mohammad Khalid et al.<sup>66</sup>

**Table No:13 Physico-chemical parameters of *Boerhaavia diffusa* Linn. root powder**

Sl. No.	Parameter	Amount (%)	Amount (%)	Amount (%)
1.	Foreign matter	Not more than 2%	Nil	Nil
2.	Total ash	Not more than 15%	10%	8.5(Punjab region) 9.15 (UP region)
3.	Acid insoluble ash	Not more than 6%	1%	1.5(Punjab region) 1.5 (UP region)

4.	Alcohol soluble Extractive	Not less than 1%	6%	-
5.	Water soluble Extractive	Not less than 4%	11%	-
6.	Moisture content	-	-	9 (Punjab region) 8.7 (UP region)
7.	Fibre content			8.67 +/- 0.02
8.	pH			

#### XIV. Phytochemical evaluation of *Boerhaavia diffusa* Linn. root powder

##### A. Qualitative Analysis

The qualitative phytochemical analysis of *Boerhaavia diffusa* Linn. root powder was mentioned by Mohammad Khalid et.al. Petroleum ether, chloroform, ethyl acetate, ethanol and water extracts were used in this study for the analysis of *Boerhaavia diffusa* Linn. root powder. Findings of the qualitative phytochemical evaluation done for carbohydrate, glycosides, alkaloids, proteins, tannins, saponins, flavonoids and terpenoids are summarized in the table below.<sup>66</sup>

**Table No: 14 Qualitative evaluations of the phytoconstituents of *Boerhaavia diffusa* Linn. root powder**

Phytoconstituent	Petroleum ether	Chloroform	Ethyl acetate	Ethanol	Aqueous
Carbohydrate	-	-	-	+	+
Glycosides	-	-	-	+	+
Alkaloids	-	-	-	+	+
Proteins	-	-	-	+	+
Tannins	-	-	-	+	+
Saponins	-	-	-	+	+
Flavonoids	-	-	-	+	+
Terpenoids	-	+	+	+	+

##### B. Quantitative Analysis



Quantitative estimation of phytochemicals Methanolic extract of root was described by Shanmugapriya et.al for total saponins, total alkaloids, total carbohydrates, total proteins and total tannins. The findings are tabulated below.<sup>67</sup>

**Table No: 15 Quantitative phytochemical evaluation of *Boerhaavia diffusa* Linn. root powder**

Contents%	<i>Boerhaavia diffusa</i> Linn. root
Total phenol	217.70±15.23
Flavonoids	179.22±12.53
Terpenoids	44.89±3.08
Tannin	94.15±6.58

### C. Fluorescence evaluation

Fluorescence analysis of powdered root by Shivkumar Shukla et al. using different chemicals and the colour was observed with the help of UV spectrophotometer.<sup>65</sup>

**Table No:16 Fluorescence analysis of *Boerhaavia diffusa* Linn. root powder**

Reagent	Observation at day light	Observation at 366 nm
Powder a sit	Brown	Dark cream
1 N HCL	Brown	Dark green
1 NaOH(methanol)	Green	Light green
1 NaOH	Dark brown	Dark green
50% KOH	Dark brown	Green
50% H <sub>2</sub> SO <sub>4</sub>	Dark brown	Dark green
Conc. H <sub>2</sub> SO <sub>4</sub>	Black	Black
50% HNO <sub>3</sub>	Brown	Black
Conc. HNO <sub>3</sub>	Brownish red	Black
Glacial acetic acid	Brownish green	Green

Iodine water	Brown	Black
50% HCl	Brown	Green
Conc. HCl	Brownish black	Green
Picric acid	Brown	Light green
Acetone	Brown	Whitish green
50% FeCl <sub>3</sub>	Dark green	Black
50% Ammonia	Brown	Green

## XV. Chromatographic evaluation of the root of *Boerhaavia diffusa* Linn.

### A. GC-MS evaluation

Twenty compounds were identified from the ethanolic extract of root of through GC-MS analysis done by Shanmughapriya A et al. N-Hexadecanoic Acid (33.21%) is identified as the major component. The compounds identified with their retention time and peak area percentage are tabulated below.<sup>67</sup>

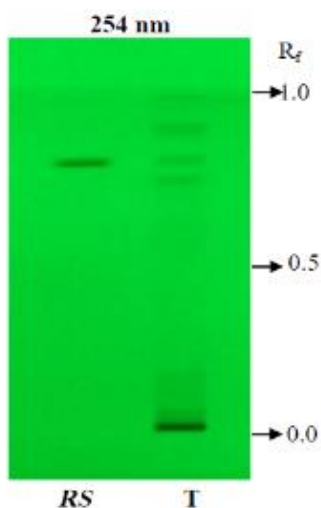
**Table 17: List of compounds from the root of *Boerhaavia diffusa* Linn. isolated by GC-MS analysis**

Sl. No	Compound name	Retention. Time	Peak area %
1	Benzene, 1,4-Diethyl-	7.492	0.82
2	4H-Pyran-4-One, 2,3-Dihydro-3,5-Dihydroxy-6-Methyl	9.100	1.38
3	2(4H)-Benzofuranone,5,6,7,7a-Tetrahydro-4,4,7a-Trimethyl-, (R)-	14.978	0.64
4	Pentadecanoic Acid	17.348	1.39
5	2-Hexadecen-1-ol, 3,7,11,15- Tetramethyl	18.234	3.78
6	2-Isopropyl-5-Methyl-1-Heptanol	18.309	1.17

7	3,7,11,15-Tetramethyl-2- Hexadecen-1-Ol	18.505	0.76
8	Oxirane, Tetradecyl	18.713	1.20
9	Tetracosanoic Acid, Methyl Ester	19.170	0.70
10	N-Hexadecanoic Acid	19.545	33.21
11	1-Hexadecanol, 2-Methyl-	20.825	0.79
12	9,12,15-Octadecatrienoic Acid, Methyl Ester	21.060	1.08
13	phytol Isomer	21.174	2.32
14	9,12-Octadecadienoic Acid	21.412	8.92
15	9,12,15-Octadecatrienoic Acid, Methyl Ester	21.501	31.68
16	Octadecanoic Acid	21.665	6.98
17	Ethyl (9z,12z)-9,12- Octadecadienoate	21.808	1.34
18	N-Hexadecanoic Acid	21.927	0.65
19	4,7-Methano-5h-Inden-5-One	24.583	0.46
20	1,2-Benzenedicarboxylic Acid, Dioctyl Ester	28.712	0.75

### C. Thin layer Chromatography

Thin layer chromatography of the methanolic extract of root of *Boerhaavia diffusa* Linn. was mentioned in The Ayurvedic pharmacopoeia of India vol 9. It was done on a precoated silica gel 60F254 plate using boeravinone B as a reference standard. 10 ml each of the test and standard solutions were applied at a height of 10 mm from the base of a 10 x 5 cm TLC plate and developed up to 8 cm from the base of the plate using the mobile phase: toluene: ethyl acetate: formic acid (4.0: 5.0: 1.0). Examined under UV 254nm. The chromatographic profile of the test solution shows a band corresponding to that of the standard solution.<sup>63</sup>

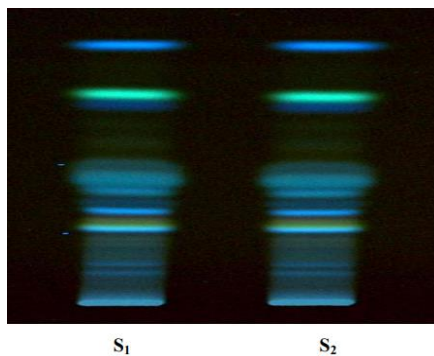


RS=: Boeravinone B, T=Test solution

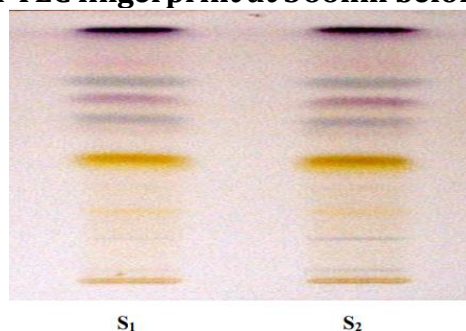
**Picture No: 4 TLC of *Punarnava***

#### **D. High Performance Thin Layer Chromatography Root Powder**

High Performance Thin Layer Chromatography by Mohammad Khalid et al, in which two spots of the sample ethanolic extract of root of *Boerhaavia diffusa* Linn. were applied in the TLC plate. Major spots R<sub>f</sub> values with colour were recorded under 366nm, after derivatization 366nm and UV light.<sup>66</sup>



**Picture No: 5 HPTLC fingerprint at 366nm before derivatization**



**Picture No:6 HPTLC fingerprint after derivatization in UV light**

**Table No 18: List of Rf values**

Rf values	At 366nm Before derivatization		At visible light	
	Test solution S1	Test solution S2	Test solution S1	Test solution S2
Rf 1	0.12 (sky blue)	0.12 (sky blue)	0.08 (light brown)	0.08 (light brown)
Rf 2	0.14 (sky blue)	0.14 (sky blue)	0.24 (light brown)	0.24 (light brown)
Rf 3	0.22 (sky blue)	0.22 (sky blue)	0.30 (light yellow)	0.30 (light yellow)
Rf 4	0.24 (yellowish green)	0.24 (yellowish green)	0.40 (pinkish brown)	0.40 (pinkish brown)
Rf 5	0.330 (sky blue)	0.330 (sky blue)	0.52 (brown)	0.52 (brown)
Rf 6	0.36 (sky blue)	0.36 (sky blue)	0.60 (yellow)	0.60 (yellow)
Rf 7	0.40 (sky blue)	0.40 (sky blue)	0.70 (brown)	0.70 (brown)
Rf 8	0.58 (sky blue)	0.58 (sky blue)	0.80 (black)	0.80 (black)
Rf 9	0.60 (whitish yellow)	0.60 (whitish yellow)	-	-
Rf 10	0.80 (sky blue)	0.80 (sky blue)	-	-

**XVI. Phytoconstituents of root of *Boerhaavia diffusa* Linn.**

A wide range of phytoconstituents were detected in the roots of *Boerhaavia diffusa* Linn. Detailing of numerous chemical constituents can be found in various text books and by Shikha Mishra et al., Kuldeep Rajoot et al., Pranati Nayak et al. and Somenath Ghosh et al.<sup>68,69,70,71</sup>

**Table No 19: Phytoconstituents of root of *Boerhaavia diffusa* Linn.**

Chemical Class	Compounds
Alkaloid	Punarnavine, Liriodenine
Flavonoid	C-Methyl flavone - Borhaavone Isoflavone 2' -O-Methyl abronisoflavone
Rotenoids	Boeravinones A, B, C, D, E, F Boeravinones G, H Boeravinones I, J 9-O-Methyl-10-hydroxy coccineone E Diffusarotenoid 6-O-Demethyl-boeravinone H 10-Demethyl boeravinone C Coccineones E, B Boeravinones M, P, Q, R, S

Phenolic Glycoside	Punarnavoside
Amino acids	Alanine Arginine Aspartic acid Glutamic acid Leucine Methionine Ornithine Phenylalanine Proline Serine Threonine Tryptophan Tyrosine Asparagines Glycine Valine
Acids	Tetracosanoic acid Hexacosanoic acid Stearic acid Palmitic acid Boerhavic acid
Fatty acid	Triacont-24-en-1-oic acid
Lignans	Liriodendrin Syringaresinol mono- $\beta$ - D-glucoside
Phenolic acid	Caffeoyltartaric acid,
Xanthone	Boerhavine
Purine nucleoside	Hypoxanthine-9-L-arabinofuranoside
Sterol	Boerhavisterol
Sterol ester	Boeravilanostenyl benzoate
Ecdysteroid	$\beta$ -Ecdysone
Hydrocarbons	Boeradiffusene, Henriacontane

## XVII. Pharmacological evaluation of the root of *Boerhaavia diffusa* Linn.

### Hepatoprotective effect

#### *In vivo* studies

In vivo study conducted by Rajkumari gulati et.al assessed the hepatoprotective activity of 50% ethanolic extract of roots *Boerhaavia diffusa* Linn. against country made liquor induced hepatotoxicity in albino rats fed on controlled calorie diet. Albino rats were divided into three groups of 10 rats each. The test drug (100 mg/100 g body weight/day) protected the rats from hepatotoxic action as evident from changes in serum alanine

aminotransferase (ALT), Triglycerides (TG), Cholesterol and total lipid levels in both serum and tissues. Histopathological studies showed marked reduction in fat deposits in animals.<sup>72</sup>

A study conducted by Rawat AKS et.al assessed *Boerhaavia diffusa* Linn. root have protective effects against hepatic injury caused by thioacetamide. Thickness of roots and form of dose (either aqueous or powder) were studied for their hepatoprotective action to prove the claims made by the different tribes of India. The hepatoprotective activity of roots of different diameters collected in three seasons, rainy, summer and winter, were examined in thioacetamide intoxicated rats. The results showed that an aqueous extract (2 ml/kg) of roots of diameter 1–3 cm, collected in the month of May (Summer), exhibited marked protection of a majority of serum parameters, i.e., GOT, GPT, ACP and ALP, but not GLDH and bilirubin, thereby suggesting the importance of proper size and time of collection of *Boerhaavia diffusa* Linn. roots for the most desirable results.<sup>73</sup>

A study was conducted by Noor ul ain et.al. with the ethanolic extract of root of *Boerhaavia diffusa* Linn. against oxaliplatin induced hepatotoxicity in male wistar rats, which were divided into three groups. Control group treated with 0.9% normal saline, second group oxaliplatin treated group and third group were prophylactically treated with ethanolic extract of root sample. and then with oxaliplatin in order to assess the protective effects of root sample against the toxicity of oxaliplatin. The levels of liver enzymes ALT, AST and  $\gamma$ -GT were significantly reduced in the group prophylactically treated with *Boerhaavia diffusa* Linn. when compared with the group treated with oxaliplatin. Histopathological examination of rat liver revealed that prophylactically treated group with *Boerhaavia diffusa* Linn. was effective in reducing oxidative stress induced steatohepatitis by oxaliplatin.<sup>74</sup>

## CONCLUSION

The present review article mentioned about the detailed description of the drug *Punarnava* (*Boerhaavia diffusa* Linn.) about its pharmacognosy, phytochemistry and pharmacological actions. It is used as single drug administration as well as used along with other medications.

**CONFLICT OF INTEREST:** Nil

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