

Journal of Coastal Life Medicine

journal homepage: www.jclmm.com



Document heading

doi:10.12980/JCLM.2.2014JCLM-2014-0041

© 2014 by the Journal of Coastal Life Medicine. All rights reserved.

Documentation of hypoglycemic and wound healing plants in Kodyampalayam coastal village (southeast coast of India)

Satyavani Kaliyamurthi, Gurudeeban Selvaraj*, Ramanathan Thirugnanasambandam

Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608502, India

PEER REVIEW

Peer reviewer

Dr. S. Monisha, Assistant Professor, Department of Biotechnology, Dr. G.R. Damodaran College, Bharathiar University, Coimbatore, Tamil Nadu, India. Tel: +91 95433 59343, E-mail: smonisha649@gmail.com

Co-reviewers: L. Ramkumar, Tamil Nadu, India. Dr. R. Shanmugapriya, Tamil Nadu, India.

Comments

This is a valuable research work in which authors have surveyed the antidiabetic and wound healing species in Kodyampalayam village. The activity was assessed based on direct interview with the local people and medicine man.

Details on Page 646

ABSTRACT

Objective: To document the hypoglycemic and wound healing plant species especially halophytes and associates were carried out in the coastal village of Kodyampalayam (Southeast coast of India).

Methods: The data were collected during the month of December 2011 to November 2012 with personal interviews and group discussion of local coastal fisher women community and traditional practitioner.

Results: The results indicated the traditional knowledge of 33 medicinal plant species, photographs, vernacular name, habit, active part and their mode of action. Among these, *Citrullus colocynthis*, *Coccoloba grandis*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Bruguiera cylindrica*, *Excoecaria agallocha* and *Andrographis paniculata* were discovered in huge number.

Conclusions: This study concludes medicinal uses of halophytes and associates in the coastal area. It will be needed scientific validation for development of novel therapeutic agents.

KEYWORDS

Coastal village, Halophytes, Diabetes, Wound-healing, *Rhizophora apiculata***1. Introduction**

Every living thing on the earth varies from flora to fauna system for their habits and habitats. There are twelve mega-biodiversity countries around the world, among these India has the largest biodiversity of vegetation. In the modern life style, people are lack of the physical workout. As a result it leads to various kinds of metabolic disorders and diseases. Diabetes mellitus is the major metabolic disorder, caused by either inadequate insulin production or resistance to insulin which leads to diabetes mellitus[1]. There are three major types of diabetes *viz.*, insulin-

dependent diabetes, non-insulin dependent diabetes and gestational diabetes. However most of the people suffered with Type 2 diabetes a prototype multi-factorial complex it accounts for 90% to 95% in the incidence of diabetes[2]. Nearly 2.5% to 7% of the populations were diagnosed with Type 2 and considered India as one of the leading causes of morbidity and mortality around the world[3]. Currently, insulin and oral hypoglycemic agents are used in the treatment of diabetes. The main undesirable effect of insulin is that hypoglycemia can cause brain damage, swelling, erythema and stinging[4]. Therefore several pre-clinical studies are ongoing to

*Corresponding author: Gurudeeban Selvaraj, Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608502, India. Tel: + 91 97894 45377

E-mail: gurudeeb99@gmail.com

Foundation Project: Supported by the authorities of Annamalai University and University Grants Commission, New Delhi, Grant No: UGC Ref. No.: 39-439/2010. (SR) dated 06.01.2011.

Article history:

Received 3 Jul 2014

Received in revised form 13 Jul, 2nd revised form 16 Jul, 3rd revised form 20 Jul 2014

Accepted 12 Aug 2014

Available online 28 Aug 2014

develop substitutes for treatment of diabetes mellitus from plant sources. Multi disciplinary ethno–botanical science deals with the direct relationship between the people and plants and also studies the complex use of plants in particular culture system for disease curing and healing^[5]. Despite treatment, ulcers readily become chronic wounds. Unresponsive wounds on debilitated patients and those with multiple medical problems should be addressed based on a triad of care: intrinsic, extrinsic and wound environment factors. Intrinsic factors include the patient’s medical status, prescribed medication and concomitant disease. Extrinsic factors include repetitive trauma, off–loading and pressure reduction. The wound environment examination includes the amount of necrotic tissue, fibrotic tissue, percent of granulation, re–epithelialization, cellular activity in the wound, and devices and dressings used for treatment. Previously, the antidiabetic potential of mangrove and associates species *viz.*, *Citrullus colocynthis* (*C. colocynthis*), *Aegiceras corniculatum* (*A. corniculatum*), *Excoecaria agallocha* (*E. agallocha*), *Rhizophora apiculata* (*R. apiculata*) and *Rhizophora mucronata* (*R. mucronata*) were reported^[6–11].

The coastal village of Kodyampalayam is located in Nagapattinam district of Tamil Nadu in southern India. There are wide ranges of halophytes and associated plant species were distributed in the village. But there is no report on ethno–botanical information in the coastal village. Hence, the present study was aimed to document the indigenous knowledge and utilization of medicinal plants along Kodyampalayam coastal village.

2. Materials and methods

2.1. Study area

Kodyampalayam coastal village is an extension of Pichavaram mangrove forest which is spread irregularly (unevenly) in the Kaveri delta. The artificial mangrove forest is situated away from 5 km southeast of the Kollidam, Nagapattinam district, Tamil Nadu, India lying between 11.33 latitude and 79.73 longitude. Kodyampalayam is 205 km distance from Chennai. The total area is covered by the mangrove, about 500 hectares. This mangrove forest is influenced by the sea water from the Bay of Bengal. It received from brackish water from Coleroon estuaries and fresh water from Kollidam. The average depth of the

estuary is 2.5 m and width 100 m to 200 m. The sand bars appear at the mouth of the estuary. Their position and extent very frequently due to tidal effect while water flow due to flooding during the monsoon resulting in erosion and later accretion in summer. The largest wetlands surrounding the eastern complex are used for aquaculture. Drainage canals from aquaculture farms and domestic sewage are discarded into the Kollidam (Figure 1).



Figure 1. Satellite view of Kodyampalayam coastal village, Nagai District, Tamil Nadu.

2.2. Ethnobotanical survey

Present information on the medicinal plants used by the local people of Kodyampalayam coastal village has been collected during 2011–2012 (Figure 2). Two to three attempts were undertaken for the interview and discussion with the local medicine man to gather maximum information about the plants used in diabetes and wound healing. The information was further verified by cross checking and validated by the common response from the village on some species of treatment. The plants were identified comparing with authentic specimens. All the recorded plants have been documented in the paper along with their scientific and local names, useful parts, habit and medicinal values. The methods adopted for investigation are those of Schultes^[12].



Figure 2. Local traditional plant practitioners with our team member.

3. Results

In the present survey revealed that the local people of

Table 1

List of medicinal flora in Kodyampalayam coastal village.

Scientific name	Vernacular name	Habit	Active parts	Mode of Action
<i>A. vasica</i>	Adhatoda	Shrub	Leaves	Leaf juice used to control blood sugar
<i>A. corniculatum</i>	Mukkuthi	Tree	Leaves	Leaf juice used for reduce pain and diabetes
<i>Aegle marmelos (A. marmelos)</i>	Vilvam	Tree	Leaves	The dried and powdered leaves are used to control blood sugar
<i>Allium cepa (A. cepa)</i>	Vengkaayam	Herb	Bulb	Bulb of the onion is used to control blood sugar
<i>Allium sativum (A. sativum)</i>	Vellai poondu	Herb	Leaves	Juices of the leaves is used to control blood sugar
<i>Aloe vera (A. vera)</i>	Kattraazhai	Herb	Leaves gel	Leaf gels are taken orally to control blood sugar
<i>A. paniculata</i>	Nilavembu	Tree	Leaves	The juice of the leaves used to control blood sugar
<i>Avicennia marina</i>	Venkandal	Tree	Leaves	Treatment for small pox and ulcer wound
<i>Azadirachta indica (A. indica)</i>	Veempu	Tree	Leaves	Powdered leaves are used to control blood sugar
<i>B. cylindrica</i>	Pannu kuchi	Tree	Leaves, roots	Leaf juice taken for digestion and inducing appetite in diabetic patients
<i>Calophyllum inophyllum</i>	Punnai	Tree	Root and Seed oil	Root and seed oil applied for the treatment of diabetic wound and scabies
<i>Cissus quadrangularis</i>	Pirandai	Shrub	Aerial part	Aerial part of the plant boiled in water and juice taken for digestion and inducing appetite in diabetic patients
<i>Citrullus colocynthis</i>	Paikomati	Prostrate	Creep fruit	Leaves are used to control blood sugar
<i>Coccinia grandis</i>	Koovai	Creeping Herb	Fruit	Fruits are used to control blood sugar
<i>Curcuma longa</i>	Kasturimanjal	Herb	Rhizome	Rhizome is used to control blood sugar
<i>Cynodon dactylon</i>	Arugampul	Grass	Leaves	Powdered leaf were taken orally to reduce blood pressure and excess blood glucose level
<i>Eclipta alba</i>	Karsalankanni	Herb	Leaves	Leaf is used to control blood sugar
<i>Excoecaria agallocha</i>	Thillai	Tree	Leaves	Leaf juice used for reduce blood glucose level and fish poison
<i>Ficus benghalensis</i>	Aalamaram	Tree	Bark	Bark decoction is used to control blood sugar
<i>Hibiscus rosasinensis</i>	Semparathai	Herb		Fresh leaf juice is taken regularly for anti-diabetic effect and Hair growth
<i>Heliotropium curassavicum</i>		Perennial herb	Leaves	Leaves used for external application to ulcers, wounds, and local inflammations
<i>Ixora coccinea</i>	Idlipoo	Shrub	Flower	Flower juice is boiled with coconut oil and applied topically on the itching places of diabetic wound to cure
<i>Melothria maderaspatana</i>	Musumusukai	Climber	Leaves	Powdered leaf juices used in the treatment for cold, cough and maintain blood sugar level
<i>Mimosa pudica</i>	Thottasiniki	Creeping	Leaves	Used for wound healing activities
<i>Ocimum sanctum</i>	Tulsi	Shrub	Leaves	Early morning a pinch of leaf is taken to control blood sugar
<i>Phyllanthus emblica</i>	Nellikkaai	Tree	Fruit	Fruits are very good antioxidant properties
<i>Rhizophora apiculata</i>	Surapunnai	Tree	Leaves	Used as an antiseptic
<i>Rhizophora mucronata</i>	Surapunnai	Tree	Leaves, roots	Juice of matured leaves and roots are used during childbirth and to control blood sugar
<i>Sesuvium portulacastrum</i>	Orputu	Perennial herb	Leaves	Used as a pickles for human consumption
<i>Suaeda maritima</i>	Mottaumiri	Herb	Leaves and shoots	The aerial parts were used for pickles preparation
<i>Suaeda monoica</i>	Poomiri	Herb	Leaves	Leaf paste were applied for wounds
<i>Solanum nigrum</i>	Manathakali	Herb	Leaves	Leaf juice were taken orally for diabetes and reduce hot temperature conditions of our body
<i>Syzygium cumini</i>	Naaval	Tree	Seeds	Dried seed powder taken orally to reduce the blood glucose level

Table 2

Photograph of anti-diabetic and wound healing species along Kodyampalayam coastal village.











Images	Systematic classification	Images	Systematic classification
	A. vasica L. Class: Magnoliopsida Order: Lamiales Family: Acanthaceae Genus: <i>Adhatoda</i> Species: <i>A. vasica</i>		A. paniculata (Burm.F.) Wall. ex Nees Class: Magnoliopsida Order: Lamiales Family: Acanthaceae Genus: <i>Andrographis</i> Species: <i>A. paniculata</i>
	A. corniculatum (L.) lanco Class: Magnoliopsida Order: Ericales Family: Myrsinaceae Genus: <i>Aegiceras</i> Species: <i>A. corniculatum</i>		A. indica Class: Magnoliophyta Order: Sapindales Family: Meliaceae Genus: <i>Azadirachta</i> Species: <i>A. indica</i>
	Aegle marmelos L. Correa Class : Magnoliopsida Order : Sapindales Family: Rutaceae Genus: <i>Aegle</i> Species: <i>A. marmelos</i>		B. cylindrica (L.) Blume Class: Magnoliopsida Order: Malpighiales Family: Rhizophoraceae Genus: <i>Bruguiera</i> Species: <i>B. cylindrica</i>
	Allium cepa L. Class: Magnoliopsida Order: Asparagales Family: Amaryllidaceae Genus: <i>Allium</i> Species: <i>A. cepa</i>		Cissus quadrangularis L. Class: Magnoliopsida Order: Vitales Family: Vitaceae Genus: <i>Cissus</i> Species: <i>C. quadrangularis</i>
	Aloe vera (L.) Burm.F. Class: Liliopsida Order: Asparagales Family: Xanthorrhoeaceae Genus: <i>Aloe</i> Species: <i>A. vera</i>		Citrullus colocynthis (L.) Schrad. Class: Magnoliopsida. Order: Cucurbitales Family: Cucurbitaceae Genus: <i>Citrullus</i> Species: <i>C. colocynthis</i>

Table 2, continued

Photograph of anti-diabetic and wound healing species along Kodyampalayam coastal village.

Images	Systematic classification	Images	Systematic classification
	Coccinia grandis L.Voigt Class: Dicotyledonae Order: Cucurbitales Family: Cucurbitaceae Genus: <i>Coccinia</i> Species: <i>C. grandis</i>		Ficus benghalensis L. Class: Equisetopsida Order: Rosales Family: Moraceae Genus: <i>Ficus</i> Species: <i>F. benghalensis</i>
	Curcuma longa L. Class Magnoliopsida. Order: Zingiberales Family: Zingiberaceae Genus: <i>Curcuma</i> Species: <i>C. longa</i>		Hibiscus rosa-sinensis L. Class: Magnoliopsida Order: Malvales Family: Malvaceae Genus: <i>Hibiscus</i> Species: <i>H. rosa-sinensis</i>
	Cynodon dactylon (L.) Pers Class: Magnoliophyta Order: Poales Family: Poaceae Genus: <i>Cynodon</i> Species: <i>C. dactylon</i>		Heliotropium curassavicum L. Class: Dicotyledons Order: Lamiales Family: Boraginaceae Genus: <i>Heliotropium</i> Species: <i>H. curassavicum L.</i>
	Eclipta prostrata L. Class: Magnoliophyta Order: Asterales Family: Asteraceae Genus: <i>Eclipta</i> Species: <i>E. prostrata</i>		Ixora coccinea L. Order: Family: Rubiaceae Order: Gentianales Family: Rubiaceae Genus: <i>Ixora</i> Species: <i>I. coccinea</i>
	Excoecaria agallocha L. Class: Magnoliopsida Order: Malpighiales Family: Euphorbiaceae Genus: <i>Excoecaria</i> Species: <i>E. agallocha</i>		Mimosa pudica L Class: Magnoliopsida Order: Fabales Family: Fabaceae Genus: <i>Mimosa</i> Species: <i>M. pudica</i>
	Ocimum sanctum L. Class: Magnoliopsida Order: Lamiales Family: Lamiaceae Genus: <i>Ocimum</i> Species: <i>O. sanctum</i>		Suaeda maritima L. Class: Dicotyledons Order: Chenopodiales Family: Chenopodiaceae Genus: <i>Suaeda</i> Species: <i>S. maritima</i>
	Phyllanthus emblica L. Class: Magnoliopsida Order: Malpighiales Family: Phyllanthaceae Genus: <i>Phyllanthus</i> Species: <i>P. emblica</i>		Suaeda monoica Forsk.ex Gmel Class: Dicotyledons Order: Chenopodiales Family: Chenopodiaceae Genus: <i>Suaeda</i> Species: <i>S. monoica</i>
	Rhizophora apiculata Blume Class: Magnoliopsida Order: Malpighiales Family: Rhizophoraceae Genus: <i>Rhizophora</i> Species: <i>R. apiculata</i>		Solanum nigrum L. Class: Magnoliopsida Order: Solanales Family: Solanaceae Genus: <i>Solanum</i> Species: <i>S. nigrum</i>
	Rhizophora mucronata Poir Class: Magnoliopsida Order: Malpighiales Family: Rhizophoraceae Genus: <i>Rhizophora</i> Species: <i>R. mucronata</i>		Syzygium cumini L. Class: Dicotyledonae Order: Myrtales Family: Myrtaceae Genus: <i>Syzygium</i> Species: <i>S. cumini</i>

Kodyampalayam coastal village, Nagapattinam District, Tamil Nadu, India were using twenty eight species of medicinally important plants belonging to 25 families. They were listed by their scientific names and vernacular names followed by active part and uses (Table 1). The medicinal plants including mangroves were categorized into shrubs

(4), herbs (12), trees (13) and remaining were grass, climbers and creepers. Majority of species belongs to Cucurbitaceae (3), Rhizophoraceae (3), Euphorbiaceae (2), Acanthaceae (2) and Liliaceae (2). As a result, more than 20 species used to control blood glucose level in the case of diabetics mellitus followed by diabetic wound, ulcer wound, itching, scabies,

inducing appetite in diabetic patients, reduce blood pressure and good antioxidant properties. The systematic classification and photographs of the plant species was showed in Table 2.

4. Discussion

Coastal people use plant part either separately or mixed together to treat diseases. The medical man pointed out the curative nature of diabetes totally depends upon natural resources for collection of plants and their parts^[13]. Generally, fresh part of the plant is used for the preparation of medicine. When fresh plant parts are not available, dried parts are also used. In the present study, different types of preparation made from medicinally important plants such as leaf/flower juice, bulb, gels, seed oil, decoction, powder, rhizome, fresh fruits and leaves. Majority of the preparation were in the form of juices (kasaya) obtained from leaves *Adhatoda vasica* (*A. vasica*), *Aegiceras corniculatum* (*A. corniculatum*), *Allium sativum* (*A. sativum*), *Andrographis paniculata* (*A. paniculata*), *Bruguiera cylindrica* (*B. cylindrica*), *Cissus quadrangularis* (*C. quadrangularis*), *Excoecaria agallocha* (*E. agallocha*), *Hibiscus rosasinensis* (*H. rosasinensis*), *Melothria maderaspatana* (*M. maderaspatana*), *Rhizophora mucronata* (*R. mucronata*) and *Solanum nigrum* (*S. nigrum*).

The people of Kodiyampalayam coastal area prescribed combination of plant species to rapidly cure the diseases. For example, flower juice of Idilipoo (*Ixora coccinea*) boiled with coconut oil and applied totally for the treatment of itching places of diabetic wound. During the ethno survey, we underwent several problems such as, some of them declined to answer few questions for fear of being investigated later by government agencies while others did not wish to divulge their professional secrets and communication language. By mutual contacts, friendly approaches and financial compensation were useful in overcoming such obstacles. Medicinal plants play an important role in providing knowledge to the researchers in the field of ethno pharmacology. Many valuable herbal drugs have been discovered by knowing that a particular plant was used by the ancient folk healers for the treatment of some kind of ailment^[14]. Apart from this additional information were also gathered while comparing the same species with other districts ethno survey. For example, leaves paste of *A. paniculata* applied externally on bitten

site of scorpion sting and snakebites along the Madurai district of Tamilnadu^[15]. Floral resources used in the local health traditions are gradually becoming extinct due to population explosion and other anthropogenic reasons. In order to reverse this trend, domestication of wild medicinal plants is of utmost importance^[16]. Partially we concentrated on conservation of coastal species like *C. colocynthis* and *Heliotropium curassavicum* through *in vitro* tissue culture techniques^[17,18]. Farmers should be involved in the cultivation of medicinal plants at least in their uncultivated land this will enhance their income and in turn help in the conservation of the species.

In conclusion, the present investigation has highlighted the antidiabetic and wound healing therapeutic value of plant species along the Kodiyampalayam coastal village. It would help the researchers for chosen the study plant for screening the pharmacological activities especially diabetes. Also new approaches of conservation strategy will be needed to restore the indigenous knowledge of medicinal plants and natural drug development for the future generation.

Conflict of interest statement

The authors declared no conflict of interest.

Acknowledgements

The authors are grateful to the authorities of Annamalai University and University Grants Commission, New Delhi, Grant No: UGC Ref. No.: 39–439/2010. (SR) dated 06.01.2011 for providing all support during the study period.

Comments

Background

One of the major metabolic disorders is type 2 diabetes mellitus. Due to adverse side of existing commercial drug the present ethnobotanical information about the anti diabetic potential plant along the Kodiyampalayam village gave useful information for choosing the plant species for future generation.

Research frontiers

The present research work carried out the ethnobotanical

survey about the anti diabetic and wound healing species along the coastal village by two or three attempts were undertaken for the interview and discussion with the local medicine man to gather maximum information.

Related reports

Scientifically evaluated the antidiabetic potential of halophytes and coastal sand dunes using *in vivo* studies on *C. colocynthis*, *A. corniculatum*, *E. agallocha* and *R. apiculata* as a result showed moderate reduction in the blood glucose level and respective biochemical parts.

Innovations and breakthroughs

This is the first report along the coastal village of Kodyampalayam village. It is appreciated the ethno survey and active parts, systematic classification and pictures.

Applications

This scientific study support and suggest the use of this plant species as an adjuvant for antidiabetic drug development.

Peer review

This is a valuable research work in which authors have survey the antidiabetic and wound healing species in Kodyampalayam village. The activity was assessed based on direct interview with the local people and medicine man. The results indicated their family, vernacular name, habit, active part and their mode of action of 33 medicinal plant species including halophytes and associates.

References

- [1] Pareek H, Sharma S, Khajja BS, Jain K, Jain GC. Evaluation of hypoglycemic and anti-hyperglycemic potential of *Tridax procumbens* (Linn.) *BMC Complement Altern Med* 2009; **9**: 48.
- [2] Cheng D. Prevalence, predisposition and prevention of type II diabetes. *Nutr Metab (Lond)* 2005; **2**: 29.
- [3] Seghrouchni I, Draï J, Bannier E, Rivière J, Calmard P, Garacia I, et al. Oxidative stress parameters in type I, type II and insulin-treated type 2 diabetes mellitus: insulin treatment efficiency. *Clin Chim Acta* 2002; **32**: 89–96.
- [4] Patil RN, Patil RY, Ahirwar B, Ahirwar D. Evaluation of antidiabetic and related actions of some Indian medicinal plants in diabetic rats. *Asian Pac J Trop Med* 2011; **4**: 20–23.
- [5] Hedberg I. Research on medicinal and poisonous plants of tropics. In: Leewenerg AJM, editor. *Past, present and future in medicinal and poisonous plants of the tropics*. Dehra Dun, India: International Book Distribution; 1987, p. 9–15.
- [6] Gurudeeban S, Ramanathan T. Antidiabetic effect of *Citrullus colocynthis* in alloxan-induced diabetic rats. *Invent Rapid Ethnopharmacol* 2010; **1**: 112.
- [7] Gurudeeban S, Satyavani K, Ramanathan T, Balasubramanian T. Antidiabetic effect of black mangrove *Aegiceras corniculatum* in alloxan-induced diabetic rats. *J Adv Pharm Technol Res* 2012; **3**: 52–56.
- [8] Satyavani K. Nanoencapsulation, characterization and ointment formulation of rutin from *Excoecaria agallocha* L. on control of type II diabetes and diabetic foot ulcer using Wistar Albino rats [dissertation]. Parangipettai, Tamil Nadu, India: Annamalai University; 2013, p. 241.
- [9] Gurudeeban S, Satyavani K, Ramanathan T. Alpha glucosidase inhibitory effect and enzyme kinetics of coastal medicinal plants. *Bangladesh J Pharmacol* 2012; **7**: 186–191.
- [10] Gurudeeban S, Satyavani K, Ramanathan T, Balasubramanian T. An *in silico* approach of alpha-ketoglutarate dependent dioxygenase FTO inhibitors derived from *Rhizophora mucronata*. *Drug Inven Today* 2012; **4**: 594–598.
- [11] Gurudeeban S, Satyavani K, Ramanathan T, Ravikumar P. Dipeptidyl peptidase IV inhibitors derived from a mangrove flora *Rhizophora mucronata*: an *in silico* approach. *Bangladesh J Pharmacol* 2012; **7**: 203–210.
- [12] Schultes RE. The role of the ethnobotanist in the search for new medicinal plants. *Lloyida* 1962; **25**: 257–266.
- [13] Kala CP. Health traditions of Buddhist community and role of amchis in trans-Himalayan region of India. *Curr Sci* 2005; **89**: 1331–1338.
- [14] Ekka NR, Dixit VK. Ethno-pharmacognostical studies of medicinal plants of Jashpur district (Chattisgarh). *Int J Green Pharm* 2007; **1**: 2–4.
- [15] Ignacimuthu S, Ayyanar M, Sankara Sivaraman K. Ethnobotanical investigations among tribes in Madurai district of Tamil Nadu (India). *J Ethnobiol Ethnomed* 2006; **2**: 25.
- [16] Uniyal B, Shiva V. Traditional knowledge on medicinal plants among rural women of the Garhwal Himalaya, Uttaranchal. *Ind J Trad Knowl* 2005; **4**: 259–266.
- [17] Satyavani K, Ramanathan T, Gurudeeban S. Effect of plant growth regulators on callus induction and plantlet regeneration of bitter apple (*Citrullus colocynthis*) from stem explant. *Asian J Biotechnol* 2011; **3**: 246–253.
- [18] Satyavani K, Dheepak V, Gurudeeban S, Ramanathan T. Direct organogenesis of seaside Heliotrope (*Heliotropium curassavicum*) using stem explants. *Pakistan J Biol Sci* 2013; **16**: 1216–1219.