



Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage: www.elsevier.com/locate/apjtd



Dengue research

doi: 10.1016/S2222-1808(16)61159-3

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Rise of mosquito bites in India: A comprehensive study on dengue

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ARTICLE INFO

Article history:

Received 15 Aug 2016

Received in revised form 24 Aug 2016

Accepted 14 Sep 2016

Available online 25 Oct 2016

Keywords:

Dengue

Medicinal plants

India

ABSTRACT

Globally, dengue has become one of the major public health concerns. However, the threat of dengue virus (DENV) has been overlooked due to lack of continuous surveillance. The four DENV serotypes are the reason for this serious illness and for its treatment till date no commercial drug is available. The increase in demand of plant based medicine and lack of anti-dengue drug and therapy has triggered to review available literature of potential anti-dengue plants against DENV serotypes. Therefore, the twin objective of this study aims to explore the current dengue data in India (2011–2016) and to review potential anti-dengue plants for their inhibition activity on DENV serotypes. Dengue data from time period 2011–2016 has been reviewed and analysed state, region and year wise in India and studies from 2002–2016 related to potential anti-dengue plant have been reviewed for their inhibition activity on DENV serotypes. It was observed that Tamil Nadu, Kerala, Gujarat, West Bengal, Maharashtra and Karnataka are highly and most consistently affected states. South region of India, most affected by DENV and 2015, 2013 reported the highest number of dengue cases. Moreover, the reviewed potential anti-dengue plants majorly show inhibition activity against DENV 2. Study revealed the current scenario of DENV and identified the largely affected areas and regions in India for development of health initiatives and future studies are encouraged to identify plant species showing inhibition activity against DENV 3, 4.

1. Introduction

Frequency rate of dengue has increased dramatically over the last 5 years. Worldwide, more than 100 countries with 100 million annual dengue cases approximately have reported dengue as a critical re-emerging arboviral disease[1]. It is estimated that billions of people living in Southeast Asia are at threat of dengue infection. India has been identified as endemic for dengue. Earlier, mostly outbreaks occurred in urban and semi-urban region of different states, but recent reports from different parts of the world as well as from India have witnessed numerous severe dengue cases.

Major health problems and most researched diseases are malaria, haemoglobinopathies, tuberculosis, fluorosis and hepatitis but dengue outbreak has not been reported, analysed and interpreted clearly from different states of the nation earlier, which leads to the significance of reviewing the current studies in Indian context.

Dengue virus (DENV) is a single stranded RNA virus which belongs to family Flaviviridae of genus *Flavivirus*, having four serotypes (DENV 1, 2, 3 and 4). DENV vectors are mosquitoes of *Aedes* species. *Aedes aegypti* is a principal vector which is a day biting, anthropophilic mosquito and for laying eggs they usually prefers clean water. The importance to study dengue serotypes has risen due to increase in the viral genetic diversity and unavailability of DENV drug. Therefore, this review will provide an updated analysis on the cases and death reported from different Indian states (from 2011 to 2016). In addition, an in depth analysis on potential anti-dengue plants literature has been done for their

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The journal implements double-blind peer review practiced by specially invited international editorial board members.

inhibition activity on serotypes of DENV which can help in vaccine development.

1.1. Clinical presentation

Clinically, post infection symptoms are malaise and headache, followed by fever, severe backache and joint pains, primarily in the areas: orbital and periarticular. There is recurrence of fever for a day or two after 24–48 h of interval, which is known as saddleback fever. Antiviral antibodies of the persons, who are previously exposed to dengue virus, possibly will improve the virus uptake into host cells and will cause disseminated intravascular coagulation, shock and death.

1.2. Pathological features

Lymphocytic vasculitis in the dermis is shown in biopsy studies of the skin rash. In serious dengue hemorrhagic fever cases, finding reveals petechial hemorrhages in the skin and hemorrhagic effusions in cavities: pleural, pericardial and abdominal. In many organs, hemorrhage and congestion are seen. Histopathological examination shows hemorrhage, perivascular edema and focal necrosis but no vasculitic or endothelial lesions. Most of the morphologic abnormalities observed are the results from disseminated intravascular coagulation and shock.

2. Dengue current status in India

Dengue is prevalent in India and has witnessed massive loss of life and property. Data were collected from Government of India Statistics. For analysis of data MS Excel has been used. Detailed analysis was carried out state wise, region wise and year wise. Figures 1–6 graphically show the dengue affected states/

union territories from 2011 to 2016 (June) which are categorised according to the regions of India that is north, south, east, west, northeast and central. It was observed that in north region highly affected states are Delhi, Punjab, and Haryana. However, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are more affected in south region. West Bengal and Orissa in east; Maharashtra, Gujarat, Rajasthan in west; Assam and Arunachal Pradesh in northeast and Madhya Pradesh in central region are states which are largely prone to DENV. Figure 7 represents consistent dengue record in south region since 2011. Followed by a large number of cases in west, the second most affected region, and then east and north regions of India. Figure 8 depicts that the highest number of cases reported were in 2015 followed by 2013, 2012 and 2014.

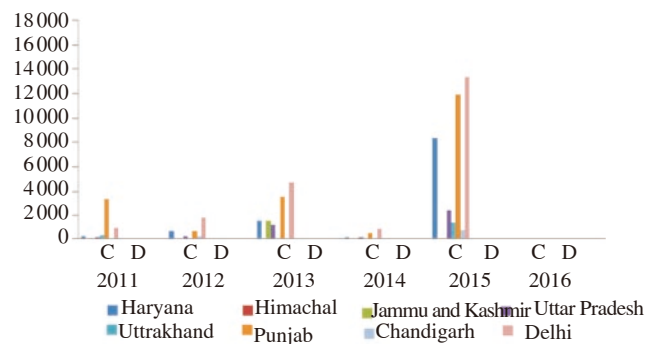


Figure 1. State wise cases and death in North India. C: Case; D: Death.

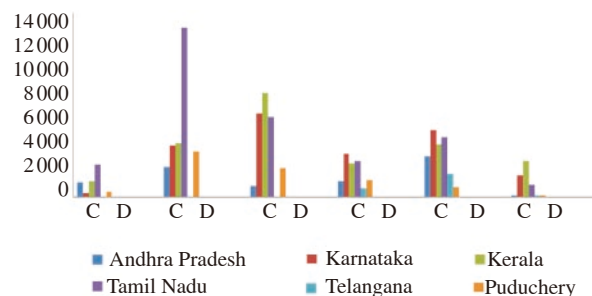


Figure 2. State wise cases and death in South India. C: Case; D: Death.

Table 1

Studies on plants with potential anti-dengue activity.

Scientific name	Family	Common name	Plant part used	DENV
<i>Andrographis paniculata</i>	Acanthaceae	Hempedu Bumi (Malaysia)	Leaves	Type 1
<i>Cladosiphon okamuranus</i>	Chordariaceae	Brown seaweed	Full plant body	Type 2
<i>Carica papaya</i>	Caricaceae	Papaya	Leaves	Against dengue fever
<i>Lippia citriodora</i>	Verbenaceae	Lemon verbena	Full plant body	Type 4
<i>Lippia alba</i>	Verbenaceae	Bushy matgrass	Full plant body	Type 2
<i>Zostera marina</i>	Zosteraceae	Marine eelgrass	Full plant body	Type1, 2, 3, 4
<i>Euphorbia hirta</i>	Euphorbiaceae	Gatas-gatas	Leaves	Dengue fever
<i>Boesenbergia rotunda</i>	Zingiberaceae	Chinese ginger	Rhizomes	Type 2
<i>Quercus lusitanica</i>	Fagaceae	Mazuphal	Full plant body	Type 2
<i>Alternanthera philoxeroides</i>	Amaranthaceae	Alligator weed	Full plant body	Type 1
<i>Ocimum sanctum</i>	Labiatae	Holy Basil, Tulsi (India)	Leaves	Type 1
<i>Leucaena leucocephala</i>	Fabaceae	White Leadtree, Petai Belalang (Malaysia)	Seeds	Type 1
<i>Gymnogongrus torulosus</i>	Phylloporaceae	Red seaweed	Full plant body	Type 2
<i>Azidarachta indica</i>	Meliaceae	Neem	leaves	Type 2

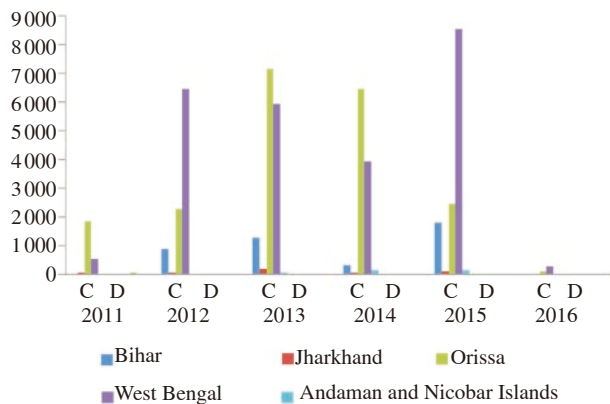


Figure 3. State wise cases and death in East India. C: Case; D: Death.

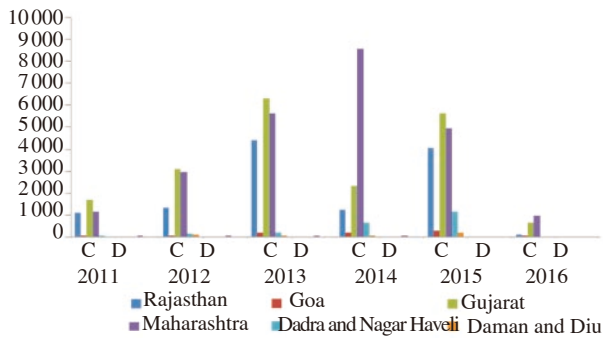


Figure 4. State wise cases and death in West India. C: Case; D: Death.

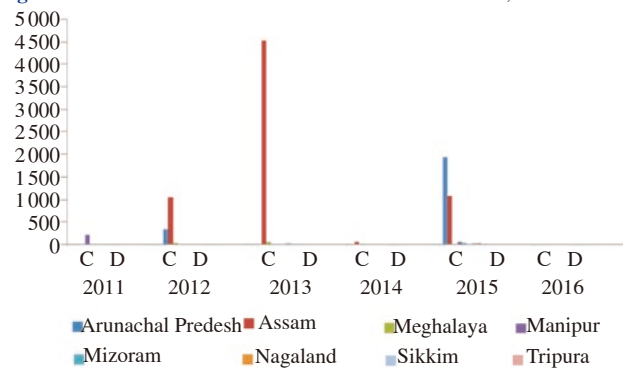


Figure 5. State wise cases and death in Northeast India. C: Case; D: Death.

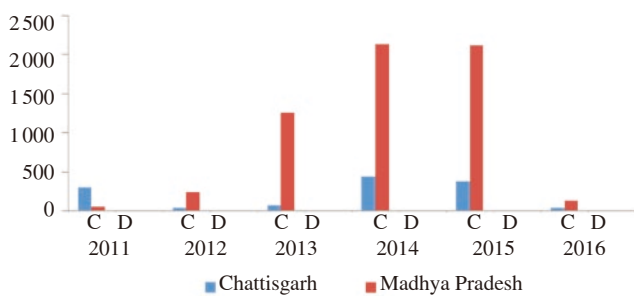


Figure 6. State wise cases and death in Central India. C: Case; D: Death.

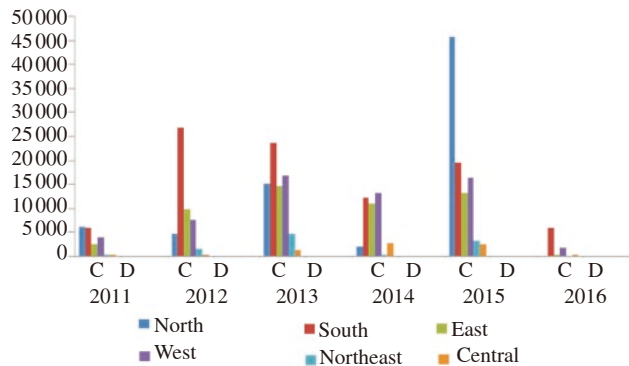


Figure 7. Region wise cases and death in India. C: Case; D: Death.

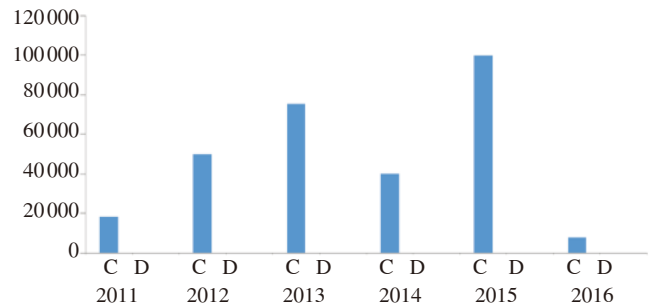


Figure 8. Overall yearwise cases and death in India from 2011 to 2016 (June). C: Case; D: Death.

Year wise analysis represents that in 2011, the most affected states were Punjab, Tamil Nadu, Orissa, Gujarat, Kerala, Delhi, Maharashtra, and Andhra Pradesh arranged in descending order. In 2012, the highest cases were seen in Tamil Nadu then West Bengal, Kerala, Karnataka, Puduchery, Maharashtra, and then Gujarat. The most severe menace of DENV was reported in Kerala, Orissa, Karnataka, Gujarat and Tamil Nadu, West Bengal, Delhi and Maharashtra, Rajasthan and Assam, and Punjab in 2013. In 2014, majorly dengue cases were seen in Maharashtra, Orissa, West Bengal, Karnataka, Tamil Nadu and Kerala. Delhi marked the highest cases of death due to dengue in 2015, then second highest cases in Punjab, then in Haryana, West Bengal, and Gujarat. However, till June 2016 yet again south region was largely affected and cases reported were high in Kerala, then Karnataka, Maharashtra, Tamil Nadu, and Gujarat.

Based on the overall analysis we concluded that Tamil Nadu, Kerala, Gujarat, West Bengal, Maharashtra and Karnataka are highly and most consistently affected states.

3. Medicinal plants

The tribals have depended on medicinal plants from ages. It has been observed that some of the plants used by tribals have not been known and recorded yet[2]. These traditional plants are the basis for modern pharma products[3]. Due to geographical and ecological constraints, 80% of the Asian and African countries are dependent on the traditional medicinal plants as reported by World Health Organization (2003)[4]. The list of potential anti-dengue plants has been shown in Table 1[5,6]. The new perspective is to find that against which dengue serotypes, the identified anti dengue plants are more effective.

Andrographis paniculata: It is an erect herb which is native to India and South Asia) which belongs to Acanthaceae family and its methanolic extract has shown inhibitory effect on DENV-1[6,7].

Cladosiphon okamuranus: It is brown seaweed found in Japan and belongs to the family Chordariaceae. It has shown inhibitory effect on DENV-2[6].

Carica papaya: It is also known as papaya and belongs to family

Caricaceae. Its leaf has shown activity against dengue fever by increasing the platelets count[7,8].

Lippia citriodora and *Lippia alba*: These plants species belong to family Verbenaceae. They have been used as essential oil and have shown inhibitory effect on DENV-4 and DENV-2, respectively[6,8].

Zostera marina: It is an aquatic plant and belongs to the family Zosteraceae. It has shown anti-dengue activity against serotype 2[6].

Euphorbia hirta: It is commonly known as Tawa Tawa and belongs to the family Euphorbiaceae. It is commonly found in India and has shown anti-dengue properties against dengue fever by increasing the platelets count[7,8].

Boesenbergia rotunda: It belongs to the family Zingiberaceae and is commonly found in Asian countries. Its inhibitory activities against DENV-2 has been observed[8].

Quercus lusitanica: It belongs to the family Fagaceae and locally known as mazu phal. The plant has shown antiviral properties against DENV-2[6].

Alternanthera philoxeroides: Commonly known as alligator weed and belong to family Amaranthaceae. This plant is effective against dengue but more exploratory studies will be helpful to find its activity against dengue serotypes[6].

Ocimum sanctum: It belongs to family Labiate and is considered most holy plant in Indian society. It is commonly known as Tulsi and is effective against DENV-1[9].

Leucaena leucocephala: It belongs to the family Fabaceae and is commonly known as white leadtree. The plant seeds have shown potential anti-dengue activity against DENV-1[6].

Gymnogongrus torulosus: This plant has shown antiviral properties against DENV-2 and belongs to family Phylloporaceae, commonly known as red seaweed[6].

Azadirachta indica: Family name is Meliaceae and is commonly known as neem. It has been used in many medicines and drugs in India for different diseases and has shown antiviral activity against DENV-2[6].

4. Conclusion

Since 19th century dengue has been reported in India. The alarming situation in 1996 has forced to develop and follow surveillance system in India. DENV is not only claiming number of cases and deaths but in India, economic burden due to DENV has increased because of lack in financial estimates and unregulated private health sector. This inability of surveillance is more concerned with the developing countries which fail to accurately access the state of health problems. However, only correct and current available data can help in successful resource allocation and goals fulfilment. The control and true burden of dengue on this country can only be known if well equipped virology laboratories,

advancement in infrastructure facilities and improvements in Indian surveillance system is developed, sustained and followed vigorously.

The current study highlights the increasing cases of DENV in south region of India and on the urgent need for development of effective health initiatives. Besides disclosing the current scenario of dengue in India, this study explored potential anti-dengue plants and their inhibitory activities. Though further laboratory investigations can be beneficial in identifying the plant species which can be used against all DENV serotypes for effective and safe anti-dengue drugs as complex pathology and the need to control all four DENV serotypes simultaneously have hampered the progress of anti-dengue drug development. Therefore, importance should be given on studies such as virus infection mechanism, plants compounds and extracts. In addition, more studies are encouraged on identifying new plant species having inhibition activity against DENV 3 and 4.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

We are thankful to the Department of Biotechnology, SRM University, Centre for Drug Design Discovery and Development (C-4D), Delhi-NCR, Sonapat, India to conduct this research review.

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