CIBMAN: Database exploring Citrus biodiversity of Manipur

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Abstract:
The rich wealth of Citrus genetic resources makes India to enjoy a remarkable position in the “Citrus belt of the world”. We have developed CIBMAN, a unique database on Citrus biodiversity of Manipur which comprises 33 accessions collected through extensive survey for more than three years. CIBMAN provides integrated access to Citrus species through sophisticated web interface which has following capabilities a) morphological details, b) socio-economic details, c) taxonomic details and d) geographical distribution. Morphological variability among Citrus accessions is due to variance in their genome which contributes to diverse agronomical traits and diverse bioactive compounds of high value. This diverse gene pool can be potential source for genetic improvement of existing cultivars and rootstocks. Systematic collection, characterization and conservation of the underutilized or lesser exploited varieties is required for incorporating in breeding program and conserve the germplasm from ever going on genetic erosion. This database will be useful for scientific validations and updating of traditional wisdom in bioprospecting aspects especially industrialization of Citrus found in the state. Further, the features will be suited for detailed investigation on potential medicinal and edible Citrus that make CIBMAN a powerful tool for sustainable management.

Availability: http://ibsd.gov.in/cibman

Background:
Citrus a delicious tropical fruit crop widely grows in the state of Manipur of North-East (NE) Region of India. The aromatic, nutritive and medicinal value of Citrus is integrally associated with day to day lifestyle of peoples of Manipur through ages. Citrus thrives in Manipur as cultivated, semi-wild and wild forms, with maximum diversity being maintained in home gardens. The commonly available Citrus fruits in the state are sweet oranges, pumelos, rough lemon, mandarins, wild orange, citron and other Citrus species. Various Citrus forms having acid taste is also widely available with ambiguities in their names. Frequently, people use to call the acid ones as champa or solom, if it is larger one. The rich germplasm of acidic Citrus group is under threat of loss as it is frequently removed from farmer’s field or home gardens in exchange for crops of higher economic value. Citrus is valued for the fruit, which is either eaten alone as fresh fruit, processed into juice, pickles or added to dishes and beverages. The rich polyphenolic compounds of Citrus such as flavanoids can act as “functional ingredients” in promotion of health and prevention of degenerative diseases [1-5]. Citrus is also potential source for compounds having high value in perfumery, cosmetic and chemotherapeutic purpose of controlling phytopathogens [6]. The NE Region of India of which Manipur is a part is considered as “natural home for Citrus” [7]. Out of the 27 species reported in India, 23 are confined to North-East Region of India [8]. Easy hybridization amongst different Citrus species and genera and unique favourable agro-climatic and soil-physiographic setup of
the region paves the way for origin of numerous forms growing in wild and semi-wild forms [9]. Citrus plants in the NE region are still growing in deep forests undisturbed by biotic factors [10, 11]. An important crop, Citrus macroptera or wild orange due to its habitat preference for wet and shady areas is growing inside deep forest of Chandil District of Manipur. Despite rich diversity in this biodiversity hotspot of the world, erosion of genetic resources of Citrus in the natural habitat is taking place due to various biotic and abiotic factors has resulted in loss of gene pool from nature and as well as from different centre of collections [12]. Even though there is availability of large Citrus germplasm and suitable conditions that favours the growth, Citrus industry of the state is in poor shape as its productivity is extremely low. Region specific topographical problem, traditional way of cultivation, lack of scientific way of nutrients, diseases and insect pest management and unavailability of quality planting material contributes to low productivity of Citrus in the state [13].

Database to retrieve the comprehensive information on Citrus will be extremely useful to modern research, and could enable new insights and discoveries concerning evolutionary relationship of gene and gene products anticipated in ethno-pharmacology. Some attempt has been made by Hazarika [12] for systematic documentation of the Citrus found in North-East India, but online interface will be certainly useful for the users to interpret more effectively and retrieve the desired information. Thus we have designed a sophisticated web database to provide comprehensive information on Citrus found in Manipur.

**CIBMAN** is first resource that provides comprehensive retrieval of information related to Citrus bioresources found in Manipur and is a unique publically available web-interface that elaborates Citrus Biodiversity of MANipur (http://ibsdd.gov.in/cibman) which provides access to the taxonomy, morphology (leaves, fruit and seed), geographical distribution, economic status, uses, references and links. **CIBMAN**'s sophisticated web based graphical user interface allows efficient retrieval of data. The reliable data content and links add an advantage in exploring data and that will make CIBMAN a comprehensive and sophisticated tool.

**Methodology:**

Surveys for availability of Citrus in nine districts of Manipur were conducted during 2008 to 2012. Data were obtained by performing personal visit to the market place, homesteads and forest. During the course of study, Citrus species were also collected from different habitats and preserved following the standard methods and identified up to genus level by following the standard taxonomic keys. The genetic resources were maintained at IBSD. The identification and authentication of the Citrus species were done at Botanical Survey of India (Shillong, Meghalaya); National Research Centre for Citrus (Nagpur, Maharashtra) and National Bureau of Plant Genetic Resources (Barapani, Meghalaya). Citrus crops are associated with socioeconomic activities of people of Manipur. Important Citrus species present in Manipur are Citrus grandis, Citrus jambhiri, Citrus medica, Citrus macroptera, Citrus pseudolimon, Citrus reticulata, Citrus sinensis and other Citrus species which are not properly known [12, 14]. There is high possibility of finding diverse form of Citrus since Manipur is located bordering to Myanmar, a region having high Citrus diversity. Proper exploitation of pumelos and acid group of Citrus for economic returns is required since farmers might opt for other crops thereby reducing the Citrus diversity. Kachai lemon a highyielding land race, cultivated in all the household of Kachai village of Ukhrul District, Manipur as community garden is a unique way for conserving the crop [15]. Conservation by community gardening should be extended to Citrus species of lesser economic value and rarely available or endangered ones [16].

In this study, the morphological characters like shape, size can give information about the diverse gene pool of Citrus available in the state (Figure 1 a, b & c). The information provided also helps in differentiation between various Citrus accessions based on the phenotypes which are highly heritable and equally expressed in all environments. So far, there is limited information available on diverse germplasm of Citrus reported from the state.

**Database Content**

CIBMAN database contains an extensive compilation on Citrus biodiversity, which can be visualized and analyzed by graphical web-interface. The database comprises of 33 Citrus accessions of which most of them are used for edible and medicinal purposes. Extensive study on evolutionary relationship is under progress to understand the taxonomic relationship of various Citrus species and also to find the distribution in different regions of the world.
conundrum retain since long. Further, biochemical and molecular data on gene and gene products will be updated after experimental validation of the data.

Figure 2: Architecture and outline of CIBMAN database

Design and Implementation:
The CIBMAN database was developed by extracting seamlessly integrating data from extensive questionnaire compiled in MS Excel. This data compiled in MySQL 5.1.41 (www.mysql.com) relational database along with cross references to taxonomy, morphology, gallery, references and links. Figure 2 elaborates the architecture and outline of CIBMAN database. The MySQL database was normalized and indexed to ensure efficient and accurate data retrieval through the query option available in CIBMAN web interface. At present search by common name, scientific name and advance options are available to the users. The regular updates to the CIBMAN database to ensure that its contents are up to date with periodic update in experimental and biochemical study.

The CIBMAN web interface developed in Apache 2.0 Handler CGI 11 (www.apache.org) runs on the Windows 2003 web server and utilizes the MySQL (XAMPP-win32-1.7.7) module to query and retrieve data from back end MySQL database (www.mysql.com). The graphical display of snaps was implemented with JAVA Script 1.6 programming (http://www.javascriptsource.com). The Google map API developer implemented for graphical representation of the distribution with respect to the GPS coordinates highlighting the specific site of sample collection.

Future Development:
The gene pool of Citrus requires systematic approach for its collection, conservation and characterization and its availability in the future. Large gene pool of wild relatives of cultivated Citrus crops is also potential source of important traits to face the unforeseen changes in climate and any further soil degradation, the sudden appearance of insect and virulent forms of pathogens. There is necessity of screening for any Citrus species having tolerance to pathogens, higher content of economically useful compounds and valuable horticultural traits. By incorporating such cultivars having valuable traits in somatic hybridization programs, crop genetic improvement of existing Citrus rootstocks and cultivars of higher bioactive compound with desired quality could be achieved [17]. The rich Citrus germplasm can also be exploited for finding new antibiotic compounds that might be useful as drug for treatment of multi drug resistant pathogens that become resistant to existing antibiotic compounds. Diverse forms of Citrus available but most of them underutilized can give us some insight on potential Citrus based industry in the state of Manipur. It is the high time to establish field gene bank at different sites as revival policy and thereby proper care needs to be taken for maintenance and better conservation of the Citrus diversity. To reduce the risk of germplasm loss, in addition to field gene banks, in vitro gene banks and cryopreservation techniques have to be developed [12,16].

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