**<tentative>** Phylogenetic analysis of Sri Lankan Cassava Mosaic Virus (SLCMV) causing Cassava Mosaic Disease (CMD) in Trincomalee, Sri Lanka based on their DNA-A sequences.

**Introduction**

Cassava (*Manihot esculenta* Crantz*)* is a perennial woody shrub belonging to family Euphorbiaceae and is cultivated primarily for its tuberous roots in tropical and neotropical nations around the world. It’s native to the southern edge of Brazilian Amazon and was domesticated by indigenous South Americans roughly 15,000 years ago (Allem, 1994);(Oslen and Schaal, 1999). Sri Lanka being a tropical island, has had cassava growing on its soils for a long time and cassava has become a well-integrated element in the Sri Lankan culinary landscape. In Sri Lanka, cassava is cultivated in dry, wet as well as intermediate zones encompassing Jaffna, Trincomalee, Anuradhapura, Gampaha, Matara, Ratnapura and Kurunegala districts. Sri Lankan Department of Agriculture (DOA) lists the following eight varieties: Shani, Suranimala, Suwarne, HORDI Mu – 01, Kirikawadi, Mu 51, HORDI 06 and CAR5 555 as customarily planted cassava cultivars in Sri Lanka. Of these eight, Kirikavadi, MU51 and CARI 555 are recommended by DOA for commercial cultivation. A diverse array of products is prepared from cassava tubers e.g., curries, porridges, crispy fries, boiled tubers, ground flour from dried tubers etc. which eloquently decorate the cuisines of Sri Lankan households. Dried flour from cassava tubers even served as an alternative staple food source when Sri Lankans faced severe shortages in imported wheat flour in the1970s, which highlights the historical and dietary significance of cassava tubers in Sri Lankans’ subsistence.

However, cassava plantations in Sri Lanka have been suffering from the Cassava Mosaic Disease (CMD) caused by Cassava Mosaic Virus (CMV) for a long time. CMD in *M. esculenta* is characterized by mosaic, mottled, misshapen, twisted and puckered leaves accompanied by tuber splitting and stunting, all of which cumulatively precipitate in reduced yields. Cassava plantations in Sri Lanka are threatened by two variants of CMV, known as Indian Cassava Mosaic Virus (ICMV) and Sri Lankan Cassava Mosaic Virus (SLCMV) (Prasangika et al., 2008). Even though the disease had been known to Sri Lankan farmers since the early 1980s, the first known academic report studying CMD in Sri Lanka comes from Salim N. and Bandumala S. H (2001) (Prasangika et al., 2008). The predominant causal agent SLCMV, is a closely related variant of ICMV and infects both commercially cultivated cassava varieties and wild cassava plants (*Manihot carthaginensis* subsp. *glaziovii*, also known as Ceara rubber)(Salim, N. and Bandumala S. H 2001). Since then, this disease and its ravages have only been studied sporadically by Sri Lankan academics, albeit meriting a sustained, serious attention. However, SLCMV seems to have drawn intense academic attention from international researchers from countries such as Vietnam, Loas, India and Cambodia as the virus spread over to their nations, causing crop losses.

SLCMV is a bipartite plant virus belonging to the family Geminiviridae, genus *Begomovirus.* The genome of SLCMV is composed of two circular ssDNAs, namely DNA-A (approximately 2,760 bases long) and DNA-B (approximately 2,737 bases long) each of which are encapsulated in separate twinned icosahedral capsids (Stanley and Gay, 1983). Genome organization of Begomoviruses is characterized by the presence of a coat protein (CP) gene (ORF V1/AV1/Coat protein) in the viral sense strand and a replication associated protein (Rep) gene (C1/AC1/Rep) in the complimentary strand. Both two ORFs start off from opposite ends of a non-coding intergenic region containing the origin of replication for the viral sense strand and the promoters of CP and Rep genes (Malathi et al., 2017). DNA-A encodes six genes AC1, AC2, AC3, AC4, AV1 and AV2 that play vital roles in defense, replication, transcription and in the synthesis of capsids. DNA-B encodes two genes BC1 and BV1 whereby BC1 gene in the anti-sense strand encodes the movement protein (MP) critical for intercellular systemic movement of virus particles in host plants and BV1 in the viral sense strand encodes the nuclear shuttle protein (NSP) that facilitates intracellular transport of the virions (Hareesh et al., 2023) (Malathi et al., 2017). DNA-A and DNA-B of SLCMVs also share a common intergenic region (~200 bases long) that encodes elements involved in replication and transcription (Saunders et al., 2002). DNA-A and DNA-B of SLCMV are mutually interdependent since DNA-A depends on DNA-B for its intracellular and intercellular movement while DNA-B depends on DNA-A for its replication and encapsidation (Malathi et al., 2017). And the sizes of these two DNAs differ by a small number of nucleotides, whereby DNA-A happens to be 21 to 23 bases longer than its DNA-B counterpart. Host-to-host transmission of SLCMV is mediated by a specific biotype of whiteflies (*Bemisia tabaci*) and SLCMV is highly sap transmissible and could be transmitted to 39 species in family Solanaceae via mechanical sap inoculation.

A study from Prasangika et al. (2008) based on *M. esculenta* germplasms concludes that most of the cassava cultivars (HORDI 28, HORDI 6, CARI 555, MU51, Kirikawadi, BW1, BW2, Wariyapola and Wagolla) planted commercially in Sri Lanka are susceptible to CMD with HORDI 6 showing the highest susceptibility and the study also identifies cultivars WA/KK/10 and 555/KK/2 to be highly resistant to CMD, based on Triple Antibody Sandwich Enzyme-Linked Immunosorbent Assay (TAS ELISA) tests performed on cassava germplasms artificially infected through wedge grafting (Prasangika et al., 2008).

This study sampled diseased *M. esculenta* leaves from select fields in Trincomalee district, Sri Lanka and compared the SLCMV viral DNA-A sequences with that of other known viral pathogens affecting *M. esculenta* plants in Sri Lanka as well as all internationally occurring variants of CMV, in a quest to discern the evolutionary relationships between them and to deduce the possible events that might have paved way for this genetic diversity to come into existence.

**Materials and Methods**

**Field Assessment of contemporary CMD situation in Trincomalee, Sri Lanka**

A brief preliminary filed survey was carried out from May 2021 to July 2021, in order to determine the disease incidence of CMD in Trincomalee district, Sri Lanka. Field visits were arranged to three different divisional secretariat (DS) divisions in Trincomalee district, namely Padavisripura, Muthur and Nilaveli. In each field, six plots (each 10 m2 in area) were selected and the number of diseased plants (n) showing stereotypical CMD symptoms and the number of total plants in the chosen plot (N) were documented. The percentage of CMD incidence per field was calculated by using the following equation (Saokham et al., 2021).

**Sample collection**

Infected cassava leaves showing conspicuous and characteristic CMD foliar symptoms were collected in June 2021 from the five different fields in Trincomalee district where cassava is being cultivated widely (Padavisripura, Muthur, Nilaveli, Kuchchaveli and Kinniya). The fields have been carefully chosen such that there’s at least a 20 - 25 km distance from one another. The harvested cassava leaves were separately packed in polythene freezer bags and stored at -20 oC in a refrigerator (Emmanuel et al., 2019).

**Total Genomic DNA extraction from infected leaf samples**

The sampled and stored CMD infected leaves from different regions were subjected to total DNA extraction by using modified CTAB extraction method. (….). DNA extracts were preserved at -20OC the virus identification using PCR techniques.

**Detection of Virus by PCR**

PCR reactions were carried out to the DNA extracts collected from different regions by using the Deng A and Deng B primers (Deng et al., 1994) that amplifies the partial sequence (530 bp) of Coat protein gene (CP – gene) specific of DNA- A component of Begomo virus. The PCR reaction was performed in a volume of 20 µL containing 3 µL of extracted DNA, 0.4 µL of Taq Polymerase (Bio mix), and 0.4 µL of Master mix (Biomix), 0.1 µL of each primer the reaction buffer provided by the manufacturer. The PCR conditions are as followed: a 94°C initial denaturation step of 4 min followed by 30 cycles of 1 min at 94°C, 45 sec at 60oC, and 1 min at 72°C and then a final extension step of 5 min at 72°C.

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