

## Can Plant Virus Infect Human Being?

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Numerous viruses infect plant, however, none of them so far is known as pathogen to animal and human beings. Only three families, *Bunyaviridae*, *Rhabdoviridae* and *Reoviridae* contain viruses known to infect plant, animal and human. Philippe Colson and coworkers from France reported in the recent issue of PLoS ONE that *Pepper mild mottle virus* (PMMoV), a plant virus might infecting human being [1]. The findings trigger to reevaluate the dogmatic concept that plant viruses are safe to human health even though numerous viruses are consumed through various types of fresh foods and food-products.

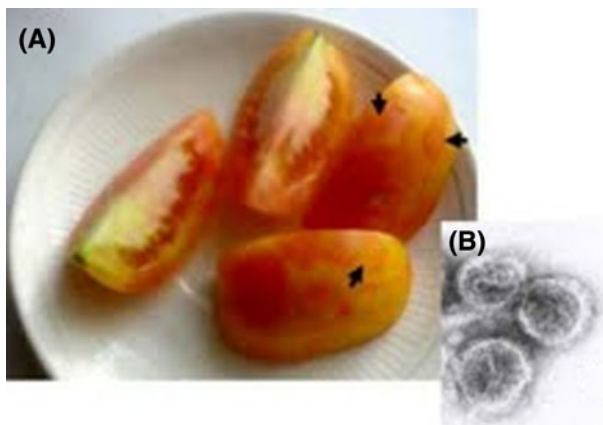
Colson et al. [1] tested stool samples of 304 adults and 137 children and 21 various food products containing chilli-pepper (Sauce, spicy powder ect) for the presence of PMMoV using real-time PCR, sequencing, and electron microscopy. PMMoV was detected in 57% of food products, 7.2% of stool samples of adults and 0.7% of children. Viral RNA sequence was recovered, virus particles were visualized and the virus present in food product was viable as it infected the host plants. In the case-control study, fever, abdominal pains and pruritus were found significantly common in the patients detected with PMMoV. Anti-PMMoV IgM antibodies were detected in all PMMoV positive patients indicating specific immune response to PMMoV. Based on these findings, Colson et al. [1] concluded that PMMoV might infect humans and cause clinical symptoms.

PMMoV, a rod-shaped non-envelop positive sense ssRNA virus belongs to the genus *Tobamovirus* and commonly infects chilli-pepper. The members under the genus

*Tobamovirus* are highly stable, contagious and require no specific insect-vector for transmission from one host to another host. *Tobacco mosaic virus*, the type species of the genus *Tobamovirus*, is well known for its stability in dead tissues of tobacco (cigarette) and also in sputum and thoracenteresis fluids of cigarette smokers [5]. PMMoV has been shown widespread in wastewater in USA [6]. *Cucumber green mottle mosaic virus*, another tobamovirus was detected in the water of Yamuna river in India and the recovered virus from water was infectious on several host plants [7]. Several of such examples show that tobamoviruses are highly stable outside living host-cell. Therefore, presence of biologically active PMMoV in food products and human stools are not surprising. Prior to the work of Colson et al. [1], PMMoV was shown as the major RNA virus in human stool by Zhang et al. [8]. The interesting observation of Colson et al. is that PMMoV is not a mere gut-inhabitant flora in human being, it interacts with the immune system and generates anti-PMMoV IgM antibody. Furthermore, PMMoV positive patients were correlated with specific clinical symptoms. Although, as they also have pointed out, the symptoms like abdominal pain and fever may be due to spicy food.

Plant viruses, such as tospovirus, rhabdovirus, reovirus, begomovirus and nanovirus are expected to have some linkage beyond their plant-hosts to insect and animal hosts. Tospoviruses, enveloped negative stranded ssRNA plant viruses, are worldwide distributed infecting numerous plants including a wide variety of freshly consumed vegetables, such as tomato, chilli-pepper, lettuce, onion, watermelon, muskmelon etc. *Tomato spotted wilt virus*, the type species of the genus *Tospovirus* is known to replicate in insect-vector, thrips and in two human cell lines [3]. *Groundnut bud necrosis virus*, one of the commonly occurring tospovirus in India, could be transmitted to

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**Fig. 1** Tomato fruit showing symptoms (rings and uneven ripening indicated by arrows) (a) of *Groundnut bud necrosis virus* (b)

tobacco plant from tissues of a ripen tomato fruit (unpublished results) (Fig. 1). This means live tospoviruses are consumed while eating fresh salad. To our opinion, tospoviruses are one group of plant viruses that may have potential for host-switching to human or higher animal. *Tomato yellow leaf curl virus*, a begomovirus (ssDNA virus) affects tomato cultivation in several countries in the world is known to reduce the lifespan and fecundity of its insect-vector, *Bemisia tabaci*, and the virus is transmitted to the next generation through eggs of *B. tabaci*. Viruses undergo alteration to inhabit in a new niche. Vertebrate-infecting ssDNA viruses, circoviruses are of such example, which have evolved from plant-infecting nanoviruses through host-switching event and then recombination with vertebrate-infecting virus [4]. Recently, Dangre et al. [2] predicted major histocompatibility complex (MHC) binding affinity of coat proteins from five species under the genus *Nanovirus*. The MHC molecules are cell surface glycoproteins, which play an important role in the host immune system, autoimmunity and reproductive success. The presence of MHC binding peptide in nanovirus prompted Dangre et al. to forecast that man might be the future host of nanovirus.

Plant based food and water are obvious route through plant viruses can get access to human body. The other possible route of access of plant virus directly to human

cells is through insects that feed on both plant and human. The insect may be vector, host or both for a virus. Mosquito is one possible insect that feed on both plant and human and is a carrier of viruses under the plant and human viruses containing families, *Bunyaviridae*, *Rhabdoviridae* and *Reoviridae*.

To establish plant virus as human pathogen, evidence of its entry into cell, replication therein and finally fulfillment of Koch's postulation is necessary. However, there is no rigid rule that plant virus can not break the barrier of their host kingdom and invade human or animal. It is possible that some plant virus may have direct or indirect role as human pathogen, but at this moment, no such study is available to consider plant virus as human pathogen.

## References

- Colson P, Richet H, Desnues C, Balique F, Moal V, Grob JJ, Berbis P, Lecoq H, Harlé JR, Berland Y, Raoult D. Pepper mild mottle virus, a plant virus associated with specific immune responses, fever, abdominal pains, and pruritus in humans. *PLoS ONE*. 2010;5(4):e10041. doi:10.1371/journal.pone.0010041.
- Dangre DM, Deshmukh SR, Rathod DP, Umare VD, Ullah I. Prediction and comparative analysis of MHC binding peptides and epitopes in *Nanoviridae* nano-organisms. *J Proteomics Bioinformatics*. 2010;3:155–72.
- de Medeiros RB, Figueiredo J, de O Resende R, De Avila AC. Expression of a viral polymerase-bound host factor turns human cell lines permissive to a plant- and insect-infecting virus. *Proc Natl Acad Sci USA*. 2005;102:1175–80.
- Gibbs MJ, Weiller GF. Evidence that a plant virus switched hosts to infect a vertebrate and then recombined with a vertebrate-infecting virus. *Proc Natl Acad Sci USA*. 1999;96(14):8022–7.
- LeClair RA. Recovery of culturable tobacco mosaic virus from sputum and thoracentesis fluids obtained from cigarette smokers with a history of pulmonary disease. *Am Rev Respir Dis*. 1967;95(3):510–1.
- Rosario K, Symonds EM, Sinigalliano C, Stewart J, Breitbart M. Pepper mild mottle virus as an indicator of fecal pollution. *Appl Environ Microbiol*. 2009;75(22):7261–7.
- Vani S, Varma A. Properties of cucumber green mottle mosaic virus isolated from water of river Yamuna. *Indian Phytopathol*. 1993;46:118–22.
- Zhang T, Breitbart M, Lee WH, Run JQ, Wei CL, et al. RNA viral community in human faeces: prevalence of plant pathogenic viruses. *PLoS Biol*. 2006;4(1):e3.