

Moving vaccines to edible form

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Edible vaccines are those vaccines that are produced using plant-based vaccine technologies. Edible vaccines are also known by several alternative names, such as food vaccines, oral vaccines, subunit vaccines and green vaccines. Here, the desired genes that encode an antigen protein for a specific disease are integrated into the genome of plant tissues, hence triggering an immune response. Various methods, such as *Agrobacterium*-mediated gene transfer, microprojectile bombardment (biolistics) method and genetically engineered plant viruses are used for the production of edible vaccines. *Agrobacterium*-mediated gene transfer is a common method that has been used to produce various effective vaccines. The Gram-negative bacteria, *Agrobacterium tumefaciens*, is commonly used as an effective delivery vehicle for immunisation. Since edible vaccines are well-tolerated and easily synthesisable, they are predominantly used over oral vaccines. Further, in humans, the path of entry of bacteria or any other pathogen is through the mucosal surfaces in the respiratory, gastrointestinal or urogenital tracts. Hence, the prime line of defence is mucosal immunity. The most efficient path of mucosal immunisation is the oral route. Oral vaccines can produce mucosal immunity, antibody-mediated immune response and cell-mediated immune response. Additionally, orally administered antigen-containing plant vaccines do not get hydrolysed by gastric enzymes due to the tough outer wall of the plant cells. Through the method of bioencapsulation, transgenic plants containing antigens are hydrolysed and released only within the intestines. The released antigens are then taken up by the microfold (M) cells that are present in the intestinal lining of the Peyer's patches and the mucosa-associated lymphoid tissues (MALT). Following this, the purified antigens are passed on to macrophages and native lymphocytes, hence producing serum immunoglobulin G (IgG), immunoglobulin E (IgE) and local immunoglobulin A (IgA) responses. These antibodies rapidly counterbalance the attack of infectious agents. Furthermore, edible vaccines do not require medical personnel, syringes or sterile injection conditions for administration. The other advantages of edible vaccines include economical production, easy administration, storage and transportation, enhanced thermostability and the ability to simultaneously deliver multiple antigens. A few of the limitations of edible vaccines are associated with their consistency, uniformity of dosage and purity. Plant-made oral vaccines may induce allergic reactions, oral intolerance and may also provoke hypersensitive responses to other proteins present in daily food products. The major challenges in the production of edible vaccines are monitoring of plant growth, the possibility of cross-contamination of genetically modified plants, acceptance of the vaccine by society and high costs. However, the benefits of edible vaccines outweigh the shortcomings. Therefore, additional research and development to overcome the aforementioned challenges will definitely aid in bringing forth the new era of edible vaccines.

Keywords: Edible vaccines, Mucosal immunity, Medicinal food, Transgenic plants, Oral vaccines, Gene transfer, Food biotechnology

Citation:

Padmini MR. Moving vaccines to edible form. The Torch. 2022. 3(30). Available from: <https://www.styvalley.com/pub/magazines/torch/read/moving-vaccines-to-edible-form>.