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Plant Molecular Farming- The Future of Food

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The world is facing over population, food crises & hunger. now we need to evolve the food system. Plant molecular farming is a technological platform to produce animal proteins with plants. It is achieved by introduction of real animal genes directly into seeds of main food crops using biotechnology and recombinant DNA technology.in molecular farming we use the complete organism, part of organisms, cell or tissue as a bio reactor for the production of commercially valuable products.

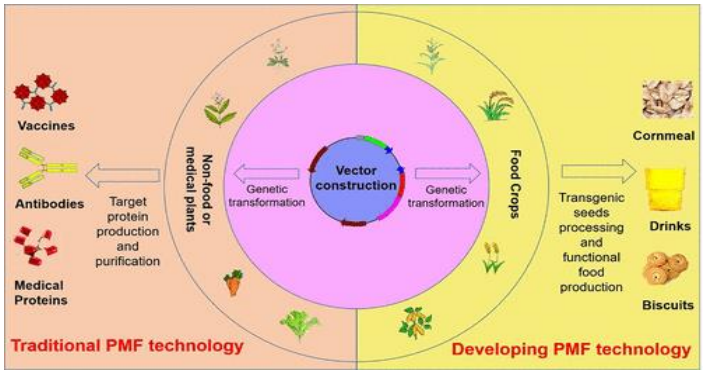
The demand for nutrient rich food increasing day by day for developing healthy world. Now PMA is majorly focused on production of antibodies, vaccines & medicinal proteins but is has not well studied in the area of food production and production of nutraceuticals. keeping these in view we need to extend the concept of PMF and then speculate how to use the PMF strategy to produce functional food. Mainly with the four major staple food crops rice, wheat, maize & soybean.

Plant molecular farming can be used to enhance the nutritional content of crops. scientist can engineer the plants to produce essential minerals & proteins by identifying the nutrient deficiency worldwide. genetic improvement through PMF can also be helpful to enhance desirable traits in crops such as shelf-life extension, drought tolerance, increase yield. PMF can facilitate the alternate protein source like plant based meat using genetic modification, crops engineered to produce proteins with meat like properties .this can help to address global food scarcity and reduce the impact on traditional livestock farming .plant molecular farming enable the production of functional food with health enhancing properties such as crop modified to produce bioactive compounds like antioxidants or anti-inflammatory agents .with PMF we may allow for customized or personalized nutrition solution. Molecular farming entails altering cellular processes to generate valuable proteins, often with therapeutic applications in humans. Human proteins are frequently targeted due to the risk of viral or prion contamination associated with proteins sourced from natural origins, a concern absent in plants. Since plants share similar protein synthesis and modification pathways with mammals, proteins produced via recombinant methods in plants are typically both soluble and functional, presenting a notable advantage over microbial expression platforms. Moreover, plants offer potential for producing industrial enzymes, research-related technical proteins, food and feed additives, and biopolymers.

There are mainly four methods of protein production from plants. 1)stable nuclear transformation of crop in the field or greenhouse 2) Stable plastid transformation 3) Transient transformation 4) Stable transformation of crop species which grow hydroponically.

Stable nuclear transformation is the most common method and produce nearly all the product available in the market place today. In this system usually *Agrobacterium tumefaciens* or particle bombardment are used to transfer of foreign genes into the plant cell. A system of plastid transformation was first discovered by swab in tobacco. Tobacco appears to be the only species in which plastid transformation is possible. Transient transformation is depending on the recombination ability of Plant viruses such as (TMV) to produce the target protein in the plant cell. In case of stable transformation of plant species that grown hydroponically the transgenics plant containing a gene coding for the target protein are grown hydroponically in a way that allows release of desired product as a root secretion into hydroponic medium.

Increasing global sustainability trends are developing large opportunity for venture-based startups. investments in alternative protein startups have increased over the past few years, and molecular



farming framework is spreading investors are increasingly invested in dimension and cost advantage of plant molecular farming some of the companies leverage molecular farming to transform the food production system such as Miruku is a new Zealand company work for developing dairy proteins that hold the potential animal free milk protein, moolec is a company which produce meat proteins through crops like soybean and pea ,Nobel foods of south San Francisco produce radially cheese protein and casein through soybeans ,kyomei is a British company which produce meat myoglobin from transgenic grass ,tobacco ,lettuce and legumes.

Along with the benefits there are certain concerns regarding to plant molecular farming such as

1) Production problem – low productivity and complicated production process
2) Time requirement – require time for initial batch production as compared to microbial system
3) Transformed plants can be eaten up by the animals
4) Horizontal transfer
5) Vertical gene transfer (pollen mediated)

In conclusion, plant molecular farming holds significant promise for revolutionizing food production. By harnessing the power of genetic engineering, we can tailor crops to produce valuable pharmaceuticals, vaccines, and industrial proteins, while also enhancing their nutritional content and improving agronomic traits. This technology offers the potential to address global challenges such as food insecurity, malnutrition, and environmental sustainability. However, to realize these benefits, it is essential to navigate regulatory frameworks, address public concerns, and ensure responsible deployment of molecular farming techniques. With continued research, innovation, and collaboration, plant molecular farming can play a vital role in shaping the future of food production, offering solutions that are both efficient and sustainable.

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