Biotechnology as a Tool to Enhance Shelf Life and Quality of Fruit Crops

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The quality of fruits can be defined as the combination of fruit attributes or characteristics which have significance in determining the degree of consumer acceptance. Fruit quality includes organoleptic and nutritional aspects closely related to their biochemical composition, especially low molecular weight organic compounds like metabolites, including sugars, organic acids, amino acids, phenolic compounds, isoprenoids, alkaloids, besides minerals, starch and cell walls. Among the various pre- and post-harvest factors which improve the postharvest quality of fruit crops, biotechnology can play an important role in enhancing the shelf life as well as quality of fruit crops.

Term "Biotechnology" refers to the technology that utilizes biological systems, living creatures or components of this to develop or create different products. It is a modern tool for the improvement of any fruit crops in the terms of quality and quality of the produce. It uses cellular and biomolecular mechanisms to produce technology and goods that enhance both the quality of our life and environment and also it shortens the time and improves precision.

Need of biotechnological approaches in fruit crops

- Overcome distant hybridization barriers
- Production of true to types
- Short breeding cycle
- More precise and selective
- Eliminates long field trial
- Easy to enhance the quality of fruit

Plant biotechnology has the potential to play a key role in the quality improvement of fruit crops. To create fruit crops with a higher yield and better fruit quality, biotechnology involves the application of tissue culture and genetic engineering. Biotechnologically improved fruits have been developed with unique characteristics that are often difficult to achieve by conventional breeding and are designed to meet the specific needs of growers or customers. By reducing the time required to obtain improved values, it advances the improvement approach.

Tissue culture

Tissue culture is based on the principle of totipotency, by which a new plant can be grown from a single cell of that plant. Anthers/microspore culture, somaclonal variation, embryo culture, meristem culture and somatic hybridization are some basic techniques of tissue culture that are being used to provide beneficial genetic variability for achieving incremental improvements in commercial cultivars.

At present, practically all fruit crops can be micro-propagated. In many horticultural crops, meristem culture has made it possible to provide planting material free of viruses. The strawberry is the first fruit crop for which the micro-propagation method has been standardized but this technique is commercially exploited mainly in banana and pineapple and at some places in strawberry also.

Through tissue culture, bananas are propagated for commercial purposes. Controlling the BBTV disease is absolutely necessary for the country's banana sector to thrive in the future. The best option is to replace contaminated areas with productions of disease-free banana plants using in vitro methods. G-9 is the most common variety of banana used for tissue culture. The produce from the tissue cultured plant get better price in market due to better quality and uniformity and in addition, this plant matures early and ratooning is unique features in them.

Genetic engineering

Genetic engineering also known as genetic modification or genetic manipulation, it is the technological modification and manipulation of an organism's gene. It is a set of technologies used to alter the genetic composition of cells, including the

exchange of genes across and within species to produce improved or novel organisms.

An organism that is produced through genetic engineering is considered to be genetically modified (GM) and the resulting entity is a genetically modified organism (GMO). The resulting organism is referred to be transgenic if it contains genetic material from another species and an organism is referred to as cisgenic, if it is created using genetic material from another member of the same species as the host or another species that can naturally breed with it.

There are many fruits which have been developed by genetic engineering with unique characteristics. Some of them are Pink glow pineapple, Super banana, Arctic apple, Honey sweet plum and transgenic papaya.

Pink glow pineapple

Pink glow pineapple is a transgenic pineapple developed by Del Monte Fresh Produce in the early 21st century. It received approval in 2016 and officially released to consumers in October 2020. Pink glow pineapples grow in Costa Rica but can be purchased in the United States and Canada. The skin of the Pink glow pineapple also has a combination of green, yellow, orange and red colors, whereas conventional pineapple is green and yellow while the flesh is pink in colour due to higher lycopene content. In conventional pineapples, lycopene, a naturally occurring enzymes, gets transformed into beta-carotene to impart yellow colour to fruit. Whereas the Pink glow pineapples contain lower levels of enzyme that causes this transition and make the pineapples pink. It is sweeter, juicier and less tart as compared to the regular pineapple. It is also aromatic and have low acidity, emitting a pleasant, fruity and subtly floral flavor with a lingering candy-like sweetness. There is delayed in ripening due to low ethylene production. The crown is removed from these pineapples prior to shipping so that the farm may sustainably transplant the crop and produce more. As a result, they are sold without their crown.

Non browning apple

Arctic apple is the trademark for a group of patented apples that contain a non-browning trait introduced through biotechnology. It is developed by Okanagan Specialty Fruits Inc by the process of genetic engineering that involved inserting modified apple DNA (that controls browning) in it. The enzyme responsible for browning is suppressed by RNA interference (RNAi) and reduced PPO to less than 10% of what would typically be found.

In 2015, it is approved for sale by USDA in America. The United States Department of Agriculture (USDA), the Food and Drug Administration (FDA), and the Canadian Food Inspection Agency (CFIA) have all declared that Arctic Apple are "as safe and healthy" as regular apple types. Arctic apple development will result in a decrease in food wastage because it maintains its crispness and appearance for a longer amount of time despite exposure or physical damage. Arctic Golden Delicious, Arctic Granny Smith and Arctic Fuji are three commercial varieties of Arctic apple.

Super banana (Golden banana)

Super banana or Golden banana is a bio fortified banana which was initiated at Queensland University of Technology (QUT), Australia to develop provitamin A (β- carotene) rich varieties. It is modified with the phytoene synthase gene (PSY2a) found in asupina banana which is naturally high in beta carotene, and introduced into Cavendish banana.

Biofortified bananas have the same yellow peel as the ordinary fruit, their flesh is more orange in colour, as a result of the high Vitamin A content and so also termed as golden banana (Super banana). Bananas' beta carotene content can be increased by the gene construct to 20 µg per gram dry weight. Being densely packed with vitamin A, it is important for our body functions including vision, skin health and the proper working of our immune system. Banana is the stable food for many African countries and this golden banana can be very helpful for making the population free from malnutrition.

Honey sweet plum

Honey sweet plum is a genetically modified plum developed by the US Department of Agriculture, which is resistant to plum pox virus (PPV). It is developed by RNAi technology and patented in the US in 2004. The gene for PPV coat protein was separated from the PPV virus and inserted into the plum DNA, which was then regenerated and grown into complete plum trees. These trees now had the additional gene in their DNA and became resistant to PPV. It contains a gene from the virus that protects the plant through acquired immunity, much like vaccination in animals. The fruit quality and quantity of Honey sweet plum was not affected by PPV infection, even when researchers added other severe plum viruses to increase the viral load. Its fruit is large and oblong in shape with a very sweet and flavorful taste.

Transgenic papaya

Transgenic papaya was developed by Dennis Gonsalves which is resistant to Papaya ring spot virus (PRSV). It was developed by particle bombardment mediated transformation technique. Papaya ring spot is a devastating viral disease in papaya and Rainbow and Sun Up are the transgenic variety which is resistant to it. Sun Up papaya was crossed with 'Kapoho', a non-engineered cultivar, yellow-flesh 'Rainbow' papaya, which is also resistant to PRSV. Currently, transgenic Papaya is being grown in Hawaii and accounts for more than 70% of Hawaii's Papaya acreage.

Altogether, the combined exploitation of genetic variability and innovative biotechnological tools may facilitate breeders to improve fruit quality taking more into account the consumer standards and the needs to move forward into more sustainable farming practices.

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