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# Breeding For Nutritional Quality in Fruit Crops

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Fruits are one of the most nutrient-dense plant-based foods since they include a wide variety of necessary vitamins, minerals, fibre, and healthy phytonutrients. Fruits play a significant role in a balanced diet. Many different techniques are now being used to change the amount of bioactive substances in food. The phrase "biofortification"or "biological fortification" refers to a food crop with improved nutritional components created using a variety of technologies, including agronomic practises (such as fertilisation, soil microorganisms that promote plant development), traditional breeding, or biotechnology methods. By employing wild species to increase the breeding pool accessible for the introgression of the desired traits during the initial phases of crossing, several enhanced varieties have been developed through inter-specific hybridization. In fact, the majority of breeding programmes are primarily concerned with agronomical and commercial qualities, such as plant yield and architecture, earliest possible output, and tolerance to biotic and abiotic stressors. The present article will give a summary of more recent research done on various fruit tree species to improve their micro/macro nutrient content (phenolic compounds, vitamins, minerals, carotenoids, carbohydrates, and lipids), as well as to decrease antinutrients, using both conventional breeding techniques and more recent NBTs.

**Phenolic compounds**

The secondary metabolites of phenolic compounds have received the greatest attention in traditional fruit tree breeding programmes as a measure of nutritional quality. For these investigations, a combination of standard and unconventional methods, such as inter- and intraspecific crossing, the use of various-omics technologies, and the deployment of genetic engineering techniques, have been employed. Although it is thought that wild T genotypes have stronger antioxidant activity than cultivated ones, there may also be variations in antioxidant strength and phenolic content between various wild accessions. In many fruit tree species, the use of wild accessions to produce genetic diversity and to increase the amount of phenolics in commercial genotypes has become a common strategy, as in persimmon papaya 201, blueberry, strawberry, apple, olive, blackcurrant and redcurrant.A major group of bioactive phenolic substances are flavonoids, which are produced via the phenylpropanoid pathway and comprise the anthocyanins, chalcones, flavones, flavonols, flavanones, and isoflavonoids. Integrative metabolomics and transcriptomics techniques are a potent method for finding candidate genes of interest. Using genetic engineering techniques to change the biosynthesis pathways for flavonoids has shown to be a successful alternative method for producing fruits with more nutritional value and better health impacts. A few biotechnological strategies with phenolic chemicals also concentrated on the use of an RNAi mechanism to both verify the operation of key genes and reroute certain biosynthetic pathways.

**Vitamins:**

Bananas have undergone biofortification processes to increase their vitamin A content in an effort to improve the nutritional health of communities in South-East Asia and Africa. The most popular traditional breeding method for bananas involves crossing seed-fertile 3x cultivars with 2x accessions that have the candidate genes, choosing 4x and 2x hybrids from the intermediate results, then crossing these hybrids to produce sterile 3x hybrid.

**Table 1: Candidate genes for the improvement of nutritional traits in fruit trees characterized by conventional molecular tools or gen tools or genetic engineering strategies.**

| S/no | Compound | Fruit tree species | Candidate genes | References |
|---|---|---|---|---|
| **1** | Flavonoids | Phenolic compounds | | |
| | | Grape vine | *VvMYBA1, VvMYBA2, VvMYB4 (−)* | Azuma *et al.* (2008) |
| | | Pear | *PcMYB10*<br>*PbMYB120 (−)* | Brendolise*et al.* (2017)<br>Song *et al*. (2020) |
| | | Apple | *MdMYBA, MdMYB1, MdMYB10* | Espley *et al*. (2007);<br>Krens*et al*. (2015);<br>Naing & Kim, 2018) |
| | | Litchi | *LcMYB1* | Naing and Kim (2018) |
| | | Strawberry | *FvMYB10, FaMYB10,* | Kui *et al*.(2014); |

| | | | | |
|---|---|---|---|---|
| | | | *FaMYB5)* | Lin-Wang *et al*. 2014) |
| | | Strawberry | *FanGalUR, FanMDAR, FanGPX, FanGR, FanSODM* | Barbey *et al*. (2020) |
| **2** | | Minerals | | |
| | Zinc, Iron | Banana | Ferritin from Soybean | Kumar *et al*. (2011) |
| **3** | | Terpenes | | |
| | Carotenoids | Strawberry | *FanPSY, FanZDS* | Barbey *et al*. (2020) |
| | | Citrus spp. | *LYCB2/E, CCD4, NCED2, AAo3, CyP707A1.* | Jiang *et al*. (2019) |
| | | Papaya | *CpCYC-B, CpLCY-B, CpPDS2, CpZDS, CpLCY-E, CpCHY-B* | Zhou *et al*. (2019) |
| | | Apple | *AtDXR* | Arcos *et al*. (2020) |
| | | Banana | *PSY2*<br>*LCY-ε (−)* | Paul *et al*. (2017)<br>Kaur, Alok, *et al*. (2020) |
| | | Lipids | | |
| | Oleic acid | Olive | *OeSAD2*<br>*SAD Hern´* | Sebastiani and Busconi (2017)<br>Andez*et al*. (2019) |
| | | Carbohydrates | | |
| | Total soluble sugars | Apple | *MdbHLH3* | Yu *et al*. (2020) |
| | Sucrose | Apple | *A6PR (−)* | Li, Li, *et al*. (2018) |
| **4** | | Antinutrients | | |
| | Allergens | Apple | *Mal d 1, Mal d 2, Mal d 3, Mal d 4* | (Dubois *et al*., 2015; Paris *et al*., 2017) |

With the desired trait. Fruits are the finest food sources of vitamin C, and for this reason, it is well recognised. Numerous investigations into the genetic diversity of various species have been conducted to find genotypes suited for breeding initiatives aiming at boosting the quantity of vitamin C in target cultivars. Apple, papaya, strawberries, and Rubus species.

**Terpenes:**

The banana, ranked among the top 10 most produced crops and the major staple food in various nations, is one of the fruit species with the highest carotenoid concentration. In new breeding lines of papaya and strawberry, the carotenoid content of additional species has also been examined. Through CRISPR/Cas9, a Cavendish banana with increased beta-carotene was produced.

**Minerals:**

To our knowledge, the transgenic banana, which has greater levels of iron and zinc compared to the natural type due to the overexpression of the soybean ferritin, is the only known example of mineral fortification in fruit tree species.

**Carbohydrates:**

The quality and marketability of fruits as well as the overall number of calories they provide in the human diet are both significantly impacted by changes or improvements in their carbohydrate content. Plants' soluble and insoluble sugar content is influenced by a variety of elements, including genotype, ripening stage, and ambient circumstances.

**Anti-nutrients**:

There are allergens in many fruit species that can make people develop oral allergy syndrome, which is characterised by gastrointestinal symptoms, urticaria, and anaphylaxis. The people who are most allergic to birch tree pollen protein (Bet v 1) are also the most susceptible. Pummelo, an intriguing breeding source for hypoallergenic citrus fruits, was indicated as the species with the least allergen city risk. Allergen concentration varies by species.

**Conclusion:**

Breeding and biotechnological methods will significantly contribute to the development of new plant-based biofortified foods, but their acceptance on the market will depend on it, especially for new products derived from biotechnologies. Additionally, their commercial exploitation would be enhanced by health claims, which are sadly not yet very common for fruits enriched with nutritional compounds.