Molecular markers in litchi: POTENTIAL APPLICATIONS AND THE ROAD AHEAD

Molecular markers can be used to verify or identify cultivars, known as DNA fingerprinting. It could be useful in cases where cultivars have been mixed up or misidentified and a tool to enhance existing breeding programmes in future.

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MOLECULAR MARKERS, ALSO known as DNA markers, are segments of DNA that represent a difference at the genome level. They can be thought of as signs along the DNA that identify desirable genetic traits or indicate genetic differences. Research on molecular markers in litchi has been ongoing for the last 17 years, with regular improvements being made.

In South Africa, work on molecular markers in litchi has been in progress for the last four years at the Agricultural Research Council-Tropical and Subtropical Crops. Initial work focussed on the use of molecular markers to investigate genetic relationships between cultivars and selections. Two types of markers were tested, viz. Simple Sequence Repeat (SSR) and Sequence-Related Amplified Polymorphism (SRAP) markers. From this work, it was concluded that the SRAP markers were better than the SSR markers in clarifying relationships between cultivars in terms of fruit size, seed characteristics and time of harvest.

A major application of molecular markers of relevance to the South African litchi industry is that markers can be used to verify or identify cultivars. This is also known as DNA fingerprinting. It requires access to suitable molecular markers as well as a DNA reference database for comparison purposes.

The process to fingerprint cultivars begins with the extraction of DNA from leaf material in the laboratory. The DNA is then PCR amplified using specific markers (also known as primers). During this stage, many copies of targeted DNA are made to allow for detection in the next step. The final stage is visualisation of the PCR products using capillary electrophoresis. This generates a DNA fingerprint where the banding patterns can be compared between the samples under investigation. Work is currently in progress to assess the suitability of specific SSR markers for this purpose.

The application of markers for DNA fingerprinting is an application that can be rolled out to the industry in the short-term. It could be useful in cases where cultivars have been mixed up or misidentified. As with any technology, there are constraints in terms of the limit of resolution of the markers. In this context, differences between cultivars
Process of DNA fingerprinting: visualisation of a DNA fingerprint.

or selections that are very similar to each other genetically might not be detected using markers. There are newer, more sensitive technologies such as Single Nucleotide Polymorphism (SNP) genotyping, however, this is significantly more expensive than SSR markers.

Looking to the future, molecular markers have an important role to play as a tool to enhance existing breeding programmes. At present, the litchi breeding programme at the ARC-TSC is based on conventional breeding to produce new, improved cultivars. Molecular markers can be applied in a Marker Assisted Selection (MAS) programme to potentially shorten the breeding cycle by enabling earlier selection of superior genotypes. For example, markers for desirable traits (such as preferred fruit colour, seed size, quality traits including pericarp characteristics and post-harvest storability), pest and disease resistance, etc. can be screened in the early stages of the breeding programme to identify selections with superior traits that can be fast-tracked or selections with undesirable traits that can be discarded. This can be done during the early phase of plant development (since DNA is extracted from leaf samples), thereby shortening the overall breeding cycle.

It must be highlighted that for MAS to be implemented, it is first necessary for research to be undertaken for the development of the specific markers. Research in this regard is far more advanced in temperate fruit crops than in tropical and subtropical ones. For example, MAS is routinely applied in the apple breeding programme at the University of Minnesota in the United States to facilitate selection for fruit colour, texture, flavour traits, storage disorders, harvest date and apple scab resistance. In the case of litchi, work is ongoing internationally so that new markers are now being developed.

The applications of molecular markers with the greatest potential benefit to the South African litchi industry are DNA fingerprinting and future MAS. At present, work is being done to improve the DNA fingerprinting technology so that it can be offered as a service to growers and other stakeholders. While this work is still in the research phase, we can assist in comparing cultivars to see how similar or different they are from selected comparators.

Implementation of MAS into the breeding programme in future will require the support of industry stakeholders to contribute towards funding such developments in association with the ARC-TSC. The goal is to use applicable biotechnology tools to promote and support the local industry.

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