Oligonucleotide-Directed Mutagenesis: accelerating innovation

For many years, plant breeding has been a trial and error exercise, whereby new varieties are produced from a cross between parental plants or through self-pollination. The process is based on identifying a desired characteristic in one plant – for instance increased resistance to a specific disease – and crossing it with another plant which allows the desired trait to appear in the offspring. However, a series of unwanted characteristics are transferred as well, which require several more breeding cycles in order to be replaced by desired traits. This form of breeding takes many years to accomplish, which represents a very long time span given the need to rapidly address issues linked to climate change and food security. In order to speed up the process and allow for more precision and efficiency, new methods are needed. Several New Breeding Techniques (NBTs) have already been developed, among which Oligonucleotide-Directed Mutagenesis (ODM).

Producing desired characteristics by single base changes

Nucleotides are organic molecules that form the basic building blocks of DNA, an organism's genetic material. ODM makes use of oligonucleotides - short molecules - to produce a specific single base change within the DNA of a plant. The technique relies on the introduction of an oligonucleotide into a plant cell; the inserted oligonucleotide is identical to part of the plant's genetic material, except for the presence of one intended change. The oligonucleotide acts as a template for the plant's natural DNA repair mechanism, which detects the mismatch between the template and the endogenous genetic material and copies the intended change into the plant's DNA. In this way a desired specific change in the plant's genetic material is produced. The oligonucleotide itself is not inserted into the DNA of the plant; it remains in the plant cell only for a short period of time before it is degraded.

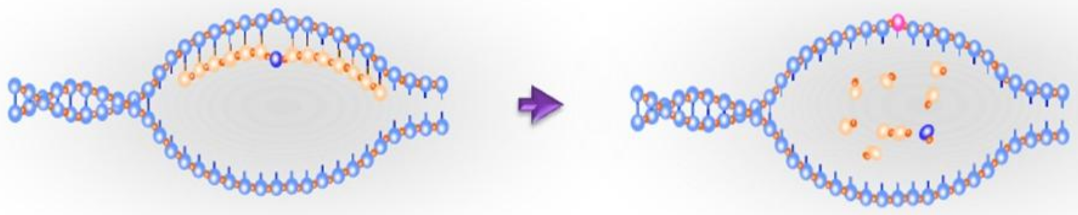

Figure 1. Simplified illustration of ODM. The left DNA helix (light blue/red) with oligonucleotide template (tan/red) containing one intended mismatch (dark blue). After the endogenous DNA repair mechanism has copied the change (pink) into the DNA, the template is degraded. The strands return to their original form (not shown) and the DNA repair mechanism copies the intended change of one strand into the complementary strand, successfully completing the process.

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Factsheet: Oligo-Directed Mutagenesis (ODM) (drafted 2013)

Accelerating plant breeding to produce new plant varieties more quickly

In practice, ODM consists of mixing plant cells with oligonucleotides, obtaining the desired change in the plant's cells and letting these cells develop into mature plants using regular tissue culture methods. The genetic improvements for useful traits, such as disease resistance, drought tolerance, higher nutritional value, etc. occur without altering the plant's overall genetic makeup or introducing any foreign genes. ODM produces results similar to the natural breeding process, only four times faster and in a controlled precise manner, as the desired trait is the only change generated and no further breeding has to be undertaken to obtain the desired plant.

As ODM does not involve the use of recombinant DNA, or does not lead to the insertion of DNA, the plant varieties that are produced as a result of its application are not covered by GM legislation and are very similar to, and indistinguishable from, those produced using conventional breeding techniques. ODM produces changes that are indistinguishable from those obtained using traditional breeding and mutagenesis, but in a much more controlled and efficient manner.

Benefits

ODM can be used to improve a wide variety of plant traits in every plant species, by repairing faulty genes or improve existing ones in a very precise and surgical manner. Examples of traits that can be obtained are for example tolerance to drought or heat (making it possible to grow crops under unfavourable climate conditions), resistance to diseases or insects (resulting in the use of less crop protection chemicals), longer shelf-life, improved nutritional quality or taste, or improved flower colours. The benefits may equally apply to field crops, horticultural crops, ornamentals or even to forestry.

ODM: a strong driver for Europe's economy and innovative potential

Small and Medium Enterprises (SMEs), which represent a large part of the EU's innovative plant breeding sector, could in particular benefit from ODM to answer market demands and develop new varieties that are more sustainable or produce higher yields in a whole range of crops. In order for this to become reality, EU Member States must align their position toward Oligonucleotide-Directed Mutagenesis. They must realize that ODM creates varieties similar to those obtained through conventional breeding or natural reproduction and are indistinguishable. Only then can the European plant breeding sector free itself from expensive regulatory burdens and enhance its competitiveness. Indeed, breeding companies, and SMEs in particular, will be able to focus their resources on research and valorisation of innovation within Europe rather than having to move outside Europe - an added value for the European agricultural sector and economy as a whole. It will also level the playing field and allow the EU to effectively compete with other markets where new breeding techniques are already actively applied.

About the NBT Platform

The NBT Platform is a coalition of SMEs, large industry and prominent academic research institutes, which strives to bring clarity to the European debate on NBTs. Its aim is to provide policy makers and stakeholders with clear and precise information on NBTs and to generate awareness about their potential benefits for the European economy and society as a whole.

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