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EPIGENETICS

Bad Karma reduces palm oil yields

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In vitro expansion of specific palm plant hybrids selected for a high oil yield has been hindered by the development of clones with 'mantled' fruits, in which oil production is drastically reduced. Researchers have now identified that DNA hypomethylation of a retrotransposon — named *Karma* — and loss of *Karma*-specific small interfering RNAs (siRNAs) leads to the mantled phenotype. Early detection of defective clones, instead of having to wait years for the plants to mature, will have a profound economic and ecological impact.

Palm oil is the most popular vegetable oil, with a wide variety of applications ranging from food products to cosmetics, detergents and biofuels. However, the ecological cost is high, given that oil palm plantations encroach into environmentally sensitive rainforests. Micropropagation of elite hybrids in culture has been heralded as a solution to maximize palm oil yield, but its success has been curtailed by the occurrence of somaclonal variations, leading to mantled fruits.

To identify the cause of the mantled phenotype, Ong-Abdullah *et al.* performed a genome-wide DNA methylation analysis by using a DNA methylation-sensitive endonuclease and hybridization to a microarray based on the oil palm (*Elaeis guineensis*) reference genome. Use of 15 independent somaclonal lineages from 4 independent sources allowed discrimination between epigenetic changes owing to tissue culture and true adaptations by the mantled fruits. DNA methylation in only one region was consistently changed in all mantled fruits, that is, a locus within the Eg*DEF1* gene — renamed *MANTLED* by the authors.

The hypomethylated region in mantled clones corresponds to a newly identified retrotransposon, *Karma*. Confirmation of differential methylation by quantitative PCR in 49 palm clones showed that this feature can be used as a marker for early identification of faulty clones with 93% sensitivity and 100% specificity. Along these lines, *MANTLED* hyper- and hypomethylation are referred to as *Good Karma* and *Bad Karma*, respectively.

Premature termination of *MANTLED*, owing to the hypomethylated splice acceptor site in *Karma*, provides a partial explanation for the mantled phenotype. In addition, the authors found that the meristem (pluripotent tissue containing undifferentiated cells) expresses a cluster of *Karma* siRNAs; these siRNAs were manifestly reduced in mantled meristems. The findings that the levels of these siRNAs were reduced after ~2–7 passages in cultured normal clones and that they were completely absent in mantled clones provide an explanation of how *in vitro* expansion contributes to the mantled phenotype. Indeed, if meristems are the source of the siRNAs, prolonged detachment of leaf cells in culture would lead to loss of siRNAs and of DNA methylation.

Identifying the molecular marker of the mantled phenotype will allow detection of worthless clones before they are planted and maintained for years. One may also speculate about ways to improve the culturing process, for example, by adding *Karma* siRNAs.

Liesbet Lieben, Associate Editor,
Nature Reviews Disease Primers

ORIGINAL RESEARCH PAPER Ong-Abdullah, M. *et al.* Loss of *Karma* transposon methylation underlies the mantled somaclonal variant of oil palm. *Nature* http://dx.doi.org/10.1038/nature15365 (2015)