

# Highlights of Analytical Chemistry in Switzerland

## The Mechanism of Chlorophyll Degradation in Plants

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The autumnal coloration of deciduous trees is a most spectacular natural phenomenon and coincides with the disappearance of chlorophyll (Chl). The fate of Chl was unknown until 1991 when the first structure of a relevant Chl catabolite was elucidated by preparative HPLC, UV, MS, and NMR.<sup>[1]</sup> Nowadays the path of Chl breakdown is largely resolved, including the structure elucidation of catabolites and the cloning of genes from catabolic enzymes.<sup>[2,3]</sup>

The structures of colorless Chl catabolites (NCCs) from leaves and fruits of various plant species exhibit a common backbone with an oxygenolytically opened chlorin ring. All remaining *meso*-carbons are saturated and as a consequence NCCs do not absorb visible light. These features indicate a largely conserved pathway of Chl breakdown within higher plants. However, different plant

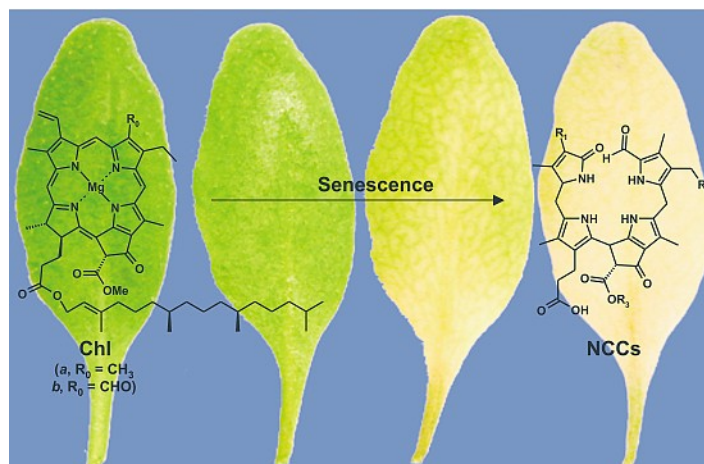
species also perform various peripheral modifications (R1-R3 in the Fig.), which increase polarity and allow deposition of NCCs inside the vacuole.

For a long time, Chl degradation during leaf senescence and fruit ripening was rationalized by the plant's aim to remobilize Chl-derived nitrogen. Obviously this is not the case. Yet Chl metabolism is a prerequisite for nitrogen reuse from Chl binding proteins, accounting for about 20% of total cellular nitrogen. Mutants defective in several of the enzymatic steps show cell death phenotypes and accumulation of photo-reactive intermediates of Chl degradation. Thus, Chl breakdown is a detoxification process. **NCCs seemed to be waste products without function, but recently they were shown to be potent antioxidants, which might contribute to the viability of ripe fruits, such as apples or pears.**<sup>[4]</sup>

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### References

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Major stages of leaf senescence in *Arabidopsis thaliana* (thale cress). The structures of chlorophyll (Chl) and final degradation products (NCCs) are shown. R1–R3 are sites of modifications found in NCCs from different plant species.

Autumn leaves – a symphony in green, red, and yellow

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