Gliadin gene control – comfort comes closer for celiac sufferers

There is little doubt that the incidence of diagnosis of celiac (coeliac) disease – mainly caused by allergy to wheat α-gliadins – is increasing. Whether this increase arises, as some suggest, from the way that bread is manufactured on a large scale or whether detection of the condition has improved is not clear. Van Herpen et al. (a joint UK–Netherlands research team; pp. 331–342) cite previous results showing that the allergic reactions exhibited by sufferers are elicited by particular epitopes in the α-gliadins encoded in the D-genome and, to a lesser extent, in the A-genome of wheat. Gliadins encoded by the B-genome are much less allergenic. Further, there is evidence that the timings of deposition during grain development of the α-gliadins encoded by the three genomes are subtly different. With this knowledge comes the possibility that the allergenicity of wheat α-gliadins could be much reduced by altering the proportions of the total α-gliadin content encoded by the three genomes. The authors used a 592-bp fragment of the promoter of an α-gliadin gene in wheat’s B-genome to drive the synthesis of a marker protein, β-glucuronidase (GUS) in transgenic plants. As expected, GUS was deposited in the starchy endosperm and in the sub-aleurone but, unexpectedly, also in the aleurone itself. Since α-gliadins were not detected in the aleurone this suggests that other controls operate in addition to those based on this promoter fragment, possibly mediated by sequences further upstream. There are also sequence differences between α-gliadin promoters from the A- and B-genomes. Unfortunately the databases do not yet contain sequences from any D-genome α-gliadin promoters. Nevertheless, the differences in temporal patterns of deposition, coupled with the already known differences in promoter sequences raise the possibility of using GM techniques to modify the proportions of the different α-gliadins to the benefit of celiac disease sufferers. The hope is that this can be done without affecting adversely the physico-chemical properties of wheat flour.

Sugar maple succumbs to strength-sapping stress

On my first visit to the USA many years ago, I was amazed to see that many of the trees in the areas of Virginia close to Washington DC were harbouring structures that looked like small, woven tents. A local resident informed me that, indeed, these were the homes of ‘tent caterpillars’ and that the infestation was particularly bad. I have seen these tents on some of my subsequent trips but certainly not at the frequency I observed on that first visit. Questions obviously arise about the amount of damage done by these herbivores. Are there any long-term effects on the life of the tree? Based on the careful and thorough analysis carried out by Hartmann and Messier (Montréal; pp. 377–387) the answer to the latter question is clearly ‘yes’. They have compared past growth rates (as indicated by growth-ring analysis) in living and recently (post-1993) dead sugar maple (Acer saccharum) trees. Growth rates were related to known previous infestations by forest tent caterpillars (larvae of Malacosoma disstria) and to soil/root disturbance caused by a thinning out (‘partial harvest’) that affected some trees 10–11 years prior to the growth-ring measurements. It was very clear that an infestation by tent caterpillars that the infestation was particularly bad. I have seen these tents on some of my subsequent trips but certainly not at the frequency I observed on that first visit. Questions obviously arise about the amount of damage done by these herbivores. Are there any long-term effects on the life of the tree? Based on the careful and thorough analysis carried out by Hartmann and Messier (Montréal; pp. 377–387) the answer to the latter question is clearly ‘yes’. They have compared past growth rates (as indicated by growth-ring analysis) in living and recently (post-1993) dead sugar maple (Acer saccharum) trees. Growth rates were related to known previous infestations by forest tent caterpillars (larvae of Malacosoma disstria) and to soil/root disturbance caused by a thinning out (‘partial harvest’) that affected some trees 10–11 years prior to the growth-ring measurements. It was very clear that an infestation by tent caterpillars strongly reduced both growth and vigour. A further infestation, even if it occurred more than 10 years later, led to a further decline in vigour. Trees most badly affected by previous infestations were very likely to die if they suffered another defoliation. Furthermore, this decline was accelerated in those trees that had been disturbed by the partial harvest. Interestingly, the partial harvest itself, in the absence of tent caterpillar infestation, did not cause any significant decline in growth or vigour. Overall, the authors conclude that the data are consistent with Manion’s tree disease model [Manion P. 1981. Tree disease concepts. Englewood Cliffs, NJ: Prentice Hall] where decline and death are ‘driven by an interaction between predisposing and inciting stresses’.

Continued overleaf
Can CAM cope with copious carbon dioxide?

One of the main causative agents of global warming, namely the increasing atmospheric CO₂ concentration, will have an effect on plant growth aside from any other effects of climate change. In general, it is expected that higher CO₂ concentrations will lead to increased photosynthetic carbon fixation in C₃ plants, at least partly because photorespiration will be suppressed. C₄ plants, with their PEP carboxylase-based CO₂ concentrating mechanism, are much less likely to benefit. But what about CAM plants? Although much of their CO₂ fixation occurs at night via PEP carboxylase, significant C₃ photosynthetic activity may occur in the light period and it is possible that day-time CO₂ fixation will be stimulated. To investigate this and other aspects of CAM, Ceusters et al. (Katholieke Universiteit, Leuven, Belgium and Newcastle University, UK; pp. 389–397) have grown a CAM bromeliad (an Aechmea hybrid) in 700 µmol mol⁻¹ CO₂ (concentration expected by the middle of the century) for 5 months. This led to a 60 % increase in carbon gain over each 24-h period. The main effects were in phase II (early in the light period) and especially in phase IV. Proportionally, the greater increases by far were in C₃ fixation, although, perhaps unexpectedly, day-time C₄ fixation was also stimulated. There was no stimulation of night-time C₄ fixation. Further, because stomatal conductance was lower under elevated CO₂, water use efficiency was two-fold higher over the full 24-h period. Intriguingly, none of the extra fixed carbon was exported to produce increased biomass. Indeed, day-time export of sugars was abolished, although this was balanced by an increase in night-time export. It seems that much of the extra carbon was kept as hexose in order to provide substrates for the CAM cycle. The authors thus suggest that ‘whilst some CAM species [such as Aechmea] may not show enhanced biomass production in a higher CO₂ world, productivity could be maintained with reduced inputs of water’.

Light and leaves – periwinkle proves DAT’s the way to do it

It is estimated that even in modern western medicine, 25 % of prescribed drugs are derived from plants. Admittedly over half of these are now manufactured synthetically but that still leaves a large number that are extracted from plants. Although many of these pharmaceuticals may be produced in cell cultures, others are only synthesized in specific types of cell. One example is the monoterpene-indole alkaloid (MIA), vindoline in Catharanthus roseus, as discussed by Campos-Tamayo et al. (Yucatan, Mexico; pp. 409–415). Catharanthus roseus produces over 100 MIAs but only vindoline requires both light and the specialized cell organization of the aerial parts of the plant. Both these regulatory factors act via the activity of the last enzyme in the pathway, deacetylvindoline acetyl CoA acetyltransferase (DAT). To study the effects of both light and morphogenesis, the authors exposed shoot cultures to continuous light or to a 16-h photoperiod, monitoring the formation of new plantlets and the synthesis of vindoline over a 36-d period. Here we focus on the photoperiod experiments. Plantlet formation occurred in waves and increases in vindoline accumulation were correlated with these waves, as were peaks of DAT activity. Enzymes acting earlier in the MIA pathway did not show this correlation. However, peaks of DAT activity were not associated with peaks in transcription of the dat gene. This suggests that the changes in enzyme activity were at least in part mediated post-transcriptionally. Further, in these shoot cultures, vindoline synthesis is independent of the ORCA3 transcription factor, involved in the induction of MIAs by jasmonate. Finally, the authors used plant hormones to disrupt the genesis of new plantlets, leading to the formation of ‘de-differentiated’ cultures. Vindoline accumulation ceased and the amount in the cultures fell to zero within 14 d, as did the activity of DAT. These data thus emphasize the linkage between morphogenesis and the synthesis of a specific secondary metabolite.

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