Strigolactone mimics – new simple substituted butenolides and their bioactivity

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Introduction

Strigolactones (SLs) are plant hormones that currently receive much attention. They are active as germination stimulants for seeds of parasitic weeds of *Striga*, *Orobanche*, and *Pelipanche* spp, in hyphal branching of arbuscular mycorrhizal (AM) fungi and as inhibitors of shoot branching [1-4].
Naturally occurring SLs are present in the root exudates of many plants, especially host plants for the parasitic weeds. They invariably contain three annulated rings, the ABC scaffold, connected with a butenolide ring (D-ring) via an enol ether unit. Typical examples are (+)-strigol (**1**) and (-)-*ent*-2'-*epi*-orobanchol (**2**) (Fig. 1). For practical applications these natural SLs have a too complex structure, and therefore, SL analogues have been developed with a much simpler structure but with retention of the essential bioactivity. The most well known analogue is GR 24 (**3**) [1-4].

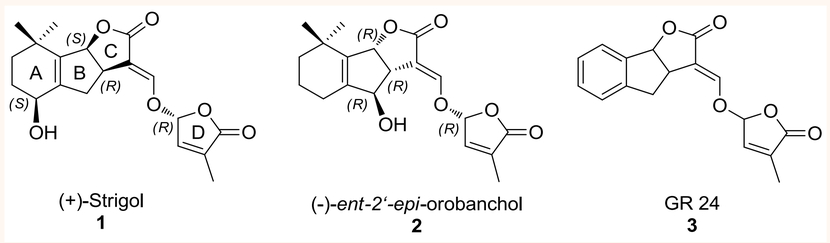


Figure 1: Structures of some natural SLs and analogue GR24.

SL mimics

Recently, it was shown that certain butenolides having a 5-phenoxy substituent (**4**) are active towards shoot branch inhibition and also moderately active in inducing germination of *S. hermonthica* seeds (~20% germination at 100 µM)[5]. Also other simple derivatives with saccharine (**5**) (*S. hermonthica:* 19% germination at 0.36 µM) and benzoates (**6**) (*S. hermonthica*: 10% germination at 0.45 µM) were prepared[6] (Fig. 2).

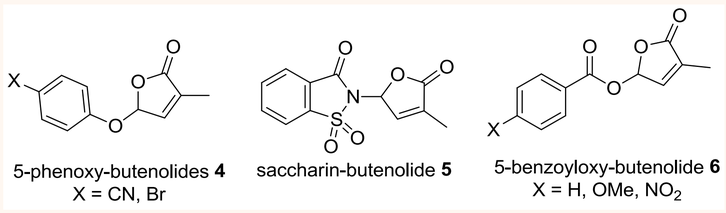


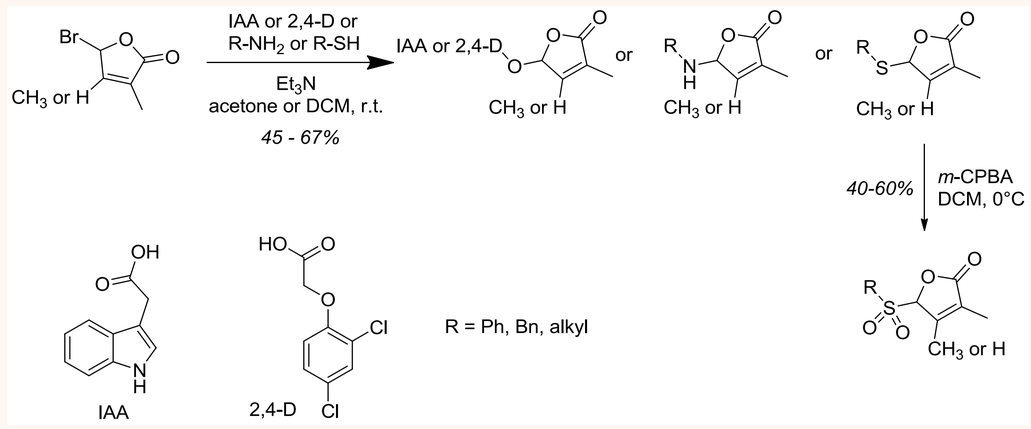
Figure 2: Structures of the first SL mimics.

The new SL mimics are of interest since they can be easily prepared and thus have a high potential for the reduction of seed banks of parasitic weeds using the concept of suicidal germination.
It is very well known that parasitic weeds are causing severe damage to important food crops in many countries over the world. Reduction of seed banks of these weeds is a possibility to eradicate these noxious parasites.

Our research group has very good knowledge about other plant growth regulators like auxins, cytokinines, jasmonates and abscisic acid and their analysis in plant material. We would like to extend our knowhow also to strigolactones. Our current topic of interest deals with the synthesis and bioactivity of new simple butenolides (SL mimics).

Synthesis

The synthesis of our butenolide derivatives is very simple. (Scheme 1). Treating of bromobutenolide **7** with auxins (IAA, or 2,4-D), thiol or primary amine in presence of base gave as corresponding product in moderate yields. The thiol derivatives are further oxidized to sulfones using *m*-CPBA as oxidative agent.



Scheme 1: Preparation of simple butenolides

Germination bioassay

Some of the newly prepared compounds (Fig. 3) were tested in parasitic plant seeds germination using *Striga hermonthica* seeds collected in Sudan (1994). In this stage of our work we used only one concentration of the compounds (1 mg/l). The known stimulants GR-24 and Nijmegen-1 were used as a positive control (Fig. 3 and 4).

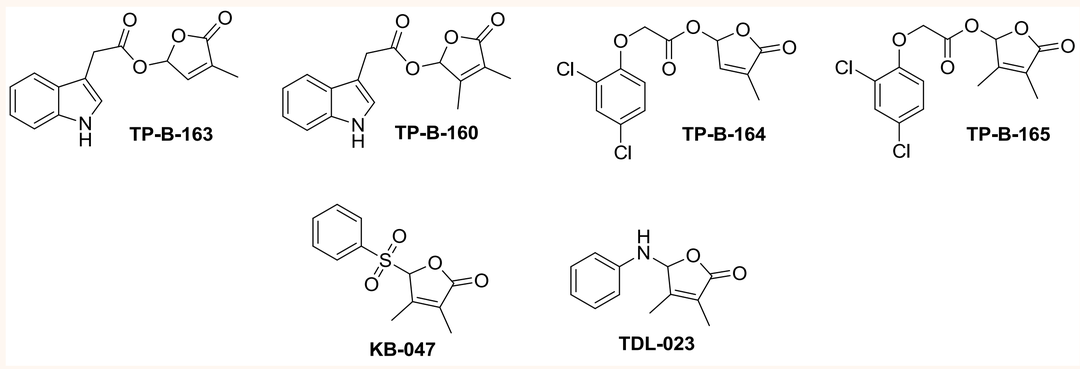


Figure 3: Butenolides subjected to a bioassay.

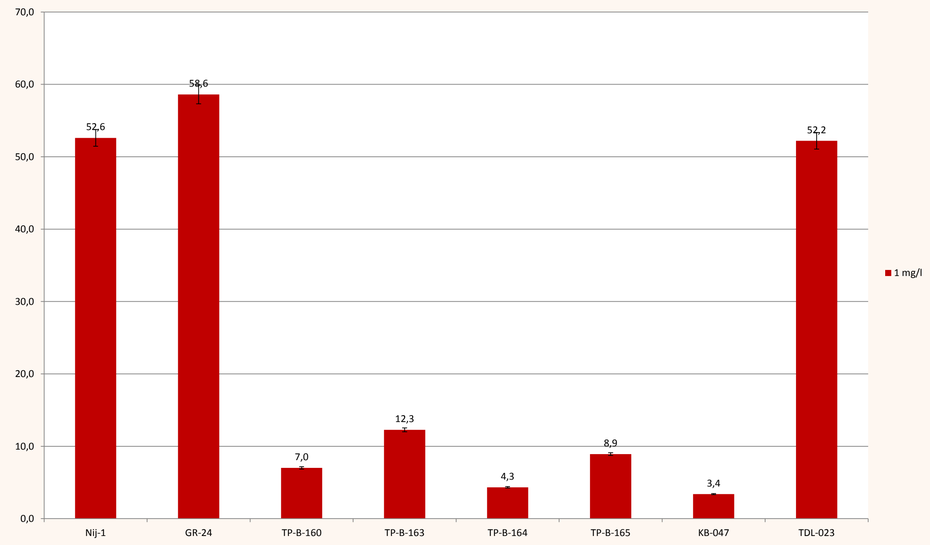


Figure 4: Bioassay of *Striga hermonthica* with **TP-B-160**, **TP-B-163**, **TP-B-164,** **TP-B-165**, **KB-047** and **TDL-023**. GR 24 and Nijmegen-1 (Nij-1) were used as a positive control in the same concentration 1mg/l. H_2O with 0,1% of acetone was used as a negative control - 1% germination – data not shown in graph. Bars represent means ± s.e.

Conclusions

A series of new simple butenolides was prepared and tested as SL mimics for parasitic seeds germination. The preliminary data reveal interesting results, especially the high activity of TDL-023 is remarkable. It should be noted that difference in the activity of TP-B-163 and TP-B-160 is small, in contrast[6] to other SL mimics which differ in structure by a methyl group at C-4. Also the activities of TP-B-164 and TP-B-165 are hardly different.
The assays need further substantiation by repeating them to check the statistical significance. Moreover, it is essential to include *Orobanche* and other seeds in this study. It is expected that *Orobanche* seeds exhibit a higher activity than *Striga* seeds.[7]
A larger set of compounds is under study in order to shed light on the structure activity relationship.

References

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