VOLATILE TERPENE PROFILES OF A, D, AND AD GENOME COTTONS: IMPLICATIONS FOR ORIGIN OF AD SPECIES

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Abstract

The volatile monoterpenes and sesquiterpenes of *Gossypium* species are localized in the lysigenons pigment glands that contain gossypol in seed and distinguish the tribe Gossypieae. Concentrations of the volatile terpenes are greatest in very young leaves and bolls. Texas race stocks of *G. hirsutum* that show resistance to insects, are used in folk medicine or contain high concentrations of (+)-gossypol were surveyed for the quality of volatile terpenes in young leaves. Plants with unique volatile patterns were crossed and backcrossed to 'TAMCOT CAMD-E' to determine the genetic control of volatile terpene synthesis. The survey and genetic studies indicate that separate single genes (and probably terpene cyclases) control the synthesis of 1) ocimene and myrcene; 2) α- and β-pinene and limonene; 3) α- and γ-terpene and 2 unknown monoterpenes; 4) caryophyllene, humulene, and caryophyllene oxide; 5) γ-bisabolene and β-bisabolol; 6) α- and β-selinene; 7) aromadendrene and spathulenol, and 8) a major unknown (located just before bisabolene in the GC profile) and 2 minor unknowns. In some cases there were distinct differences in the ratio of products formed by the same type of cyclase. For example, the ratio of pinenes to limonene were either about 10:1 or 3:1. This indicates that there are different alleles producing slightly different pinene cyclases. Similar variations were noted for caryophyllene:humulene ratios.

Species of A genome and D genome cottons, which are probably the progenitors of the AD species were surveyed for volatile terpenes to determine possible origins of specific cyclase variations. In addition the cultivated AD species *G. barbadense* also was studied. δ-Cadinene was the only volatile terpene present in all A, D, and AD species, which is consistent with its role as a precursor of gossypol. No other volatile terpene was found in the D genome species *G. thurberi* and *G. trilobum*. Both the A and D species displayed the same range of variations in volatile monoterpenes as *G. hirsutum*. That is myrcene and/or ocimene occurred in all species, whereas the pinene and terpinene groups occurred in some but not other species just as they vary among *G. hirsutum* accessions. Myrcene and the terpinene group were not found in *G. barbadense*.

The D species have several variations in volatile sesquiterpene structure that are not found in A species. Thus, they probably are the source of the aromadendrene group, the selinene group, and the major unknown found in some strains of *G. hirsutum*. Only copaene and the caryophyllene group were found in *G. barbadense*. The bisabolene group was either missing or in very low concentrations in all A and D species and *G. barbadense*, even though it makes up more than 20% of the volatile terpenes in cultivars of *G. hirsutum*. The only unique volatile sesquiterpenes found in A and D species were the selenyl alcohols and selenyl acetates in the D species *G. armourianum*, *G. harknessii* and *G. turneri*.

The volatile terpenes made by three synthetic tetraploids (*G. arboreum* x *G. davidsonii*, *G. arboreum* x *G. trilobum*, and *G. arboreum* x *G. raimondii*) were compared with those of accessions of *G. hirsutum* and *G. barbadense*. The profile of *G. arboreum* x *G. davidsonii* was in complete or close agreement with that of some door yard accessions from Mexico. Likewise, the profile of *G. arboreum* x *G. raimondii* was in complete or close agreement with that of accessions identified as *G. hirsutum* "moco" type from Brazil. The profile of *G. arboreum* x *G. trilobum* varied from that of any *G. hirsutum* accessions by two or more terpene groups. None of the profiles of the synthetic tetraploids agreed with that of *G. barbadense*.

The survey and genetic data indicate at least 7 and as many as 10 terpene cyclases that control structure of volatile terpenes in A, D and AD genome species. Additional variations result from enzymes that add oxygen to terpenes and form acetates from alcohols. The profiles are consistent with some *G. hirsutum* strains originating from crosses of *G. arboreum* x *G. davidsonii*, and other strains originating from crosses of *G. arboreum* x *G. raimondii*. More than 500 distinct volatile groups can be created genetically using genes available in *G. hirsutum*, *G. barbadense*, and *G. armourianum*.

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