TRIACYLGLYCEROLS IN RAPESEED

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Introduction

The accumulation of oil and the associated changes in fatty acid (FA) composition have been described for oilseed rape (Fowler and Downey, 1970; Norton and Harris, 1975) and closely related species (Gurr, Blades and Appleby, 1972). Recently investigations have revealed marked changes in the spectrum and composition of the triacylglycerols (TAG) during rapeseed development (Norton and Harris, 1983). As far as is known, no other comparable information is available for rapeseed but the TAG of mature seeds of Crambé abyssinica have been researched thoroughly (Gurr, Blades and Appleby, 1972).

Improvements in the FA composition of oilseed rape by breeding have been particularly successful (Downey, 1976). These changes must also be reflected in the number, relative proportion and FA composition of individual TAG species in the oil. Data on the TAG molecular species for improved and non-improved cultivars is essential if the full implications of breeding programmes are to be ascertained. Information is presented on the TAG of a non-improved winter cultivar (Panter) throughout seed development and this compared with data on TAG of improved and non-improved winter and spring cultivars.

Experimental and Discussion

The pattern of lipid and dry matter (D.M.) accumulation in developing rapeseed was similar to that described previously (Norton and Harris, 1975). Shortly after anthesis, the lipids only accounted for a small proportion of the D.M. This lipid was mainly phospho- and glyco-lipid. D.M. accumulation was slow until cell division in the embryo was completed when oil and protein deposition was initiated. At this stage the lipid content of the D.M. rapidly increased to 45% and remained at this level through to maturity. Once the process of oil and protein deposition commenced these reserve materials were synthesised in constant proportions. Much of the lipid accumulating during this phase was neutral lipid mainly TAG. At maturity approximately 90% of the seed lipid was TAG.

Seven TAG molecular species have been identified in the high erucic acid cultivar Panter throughout development (Norton and Harris, 1983). These TAG were classified according to the number of double bonds based on the molecular proportions of saturated (S), monoenoic (M), dienoic (D) and trienoic (T) FA. Throughout development considerable variations in the proportions of the individual TAG molecular species and their constituent FA were observed. At maturity, TAG molecular species M_2T, M_2D and M_3 with 5,4 and 3 double bonds respectively accounted for over 75% of the total TAG while the remainder was comprised of M_2D, $(M/S)_2D$, $(M/S)_2M$ and M_2S with 4,3,2 and 2 double bonds respectively. The minor TAG molecular species in the mature seed were never present in significant amounts at any developmental stage and exhibited considerable variation in FA composition throughout. In early seed development, all the TAG were rich in oleic acid (18:1(9)). With time this and other FA were largely replaced by erucic acid (22:1(13)) and to a much lesser extent eicosenoic acid (20:1(11)).

The distribution of FA in the respective TAG was determined by stereospecific analysis. Position 2 of the TAG was absolutely specific for 18:1(9), linoleic acid 18:2(9,12) and linolenic acid (18:3(9,12,15). Positions 1 and 3 of the TAG were occupied mainly by 22:1(13) and to a much lesser extent 20:1(11) in the same proportions. Small amounts of palmitic acid (16:0) and stearic acid (18:0) were restricted to positions 1 and 3 of the specific TAG.

A preliminary survey of three high erucic acid winter rapeseed cultivars revealed similar TAG molecular species patterns. In mature seed of cultivars Victor, Giant Winter and Janus approximately 75-80% of the TAG were present as M_2T, M_2D and M_3. The remainder consisted of TAG species of the following composition, MDT, S/MMT, S/DMD and M_2S with considerable variation from one cultivar to another. Zero erucic acid spring and winter rapeseed cultivars (Cressus and Lesira) had similar TAG compositions but these were different from the high erucic acid types. This was probably due to the fact that the FA composition of the TAG of these cultivars were approximately 60% 18:1(9), 20% 18:2(9,12) and 10% 18:3(9,12,15). M_2D was the principal TAG molecular species but other major lipids were M_2T, MDT and M_3. Minor TAG species included SMT, MD_2, S/MD_2 and M_2S. Erglu, a low erucic acid spring rape had a similar TAG composition to the zero erucic acid rapeseed cultivars.

Although this work is of a preliminary nature, it would appear that in the low and zero erucic acid varieties, the biochemical changes in the seed are not solely restricted to production of FA 18:1(9), 18:2(9,12) and 18:3(9,12,15) in place of 22:1(13) and 20:1(11). Different species of TAG rich in polyunsaturated FA are produced to accommodate the increased proportion of these FA in the seed. Although 18:1(9) clearly replaces 22:1(13) and 20:1(11) in certain major TAG, for example, M_2T, M_2D and M_3, the content of these molecular species in the oil TAG is considerably lower than in the high erucic acid rape cultivars. Thus breeding out of erucic acid leads to more complex changes in the TAG than might be expected from sample FA compositional data.

References

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