ABOUT OUR COVER

TOMATO RIPENING MUTANTS

The dictionary defines ripening as "the aging (or curing) process to develop characteristic flavor, odor, body, texture and color." The plant physiologist identifies ripening as the terminal period of maturation during which the fruit attains its full development and its maximum esthetic and edible quality (1).

Neither of these definitions adequately describe the highly synchronized and dramatic changes which occur during the relatively few hours or days in which a fruit ripens. The individual processes which constitute ripening differ for various crops as well as cultivars within crops. Thus a precise definition of ripening of a particular crop or cultivar necessitates both definition and quantification for those changes in chemical and physical properties which contribute to this maximum "esthetic and edible quality."

Environmental, cultural, and genetic factors influence the timing and nature of ripening changes. Recently, several single gene mutations with multiple effects on tomato ripening have been identified and described. Such mutants have been termed "ripening mutants" by virtue of their multiple effects on the ripening process. On the cover photograph1, ripe fruit of 'Rutgers' (top) is contrasted with fruits of approximately equivalent age of the nor mutant (center) and the rin mutant (bottom).

The ripening inhibitor (rin) mutant, first described by R.W. Robinson and M. L. Tomes (3), appeared in an F_4 breeding line developed by H. M. Munger at Cornell University. The extreme variability in maturity in this breeding line was shown to have resulted from spontaneous mutation at the rin locus which also affected sepal size conditioned by the gene for macrocalyx (mc) on chromosome 5. Robinson and Tomes suggest that a small deficiency encompassing both rin and mc probably accounts for both mutations appearing simultaneously. The most intriguing feature of the rin mutant, according to the authors, "is that so many aspects of the ripening processes are affected."

Mature fruit of the rin mutant remain firm and in sound condition for several months after harvest.

The non-ripening (nor) mutant was identified in an introduction known as "Italian Winter" (5). This cultivar was initially obtained by E. A. Kerr from the Horticultural Research Institute of Ontario from an Italian immigrant to Canada who had attempted to grow the cultivar in Ontario. Sound fruit were brought to the Vineland Horticulture Research Station in the spring from a garden crop grown the previous year. Apparently, fruit failed to mature during the normal growing season, so the plants were pulled and fruit allowed to mature on the detached vine. Our stocks of the nor mutant trace back to the few fruit which had survived the long Canadian winter suspended on a basement rafter. Similar mutants have been reported by Italian workers in cultivars collected in Southern Italy (4). The nor mutant was identified in a tomato 'Da Serbo' which is grown in home gardens in the Campania and Apulia regions of Italy and consumed during the winter months. The nor mutant was identified in a local cultivar 'Tondo Liscio di Pescara' and is allelic with nor and nor. These types are apparently grown as home garden cultivars because of their very long shelf life.

A third ripening mutant never ripe (Nr) was first identified by L. L. Morris of the University of California at Davis in a chimeral fruit, part of the tissue of which was heterozygous for Nr. Since the mutant phenotype is dominant, spontaneous mutants and/or chimeral fruit can be readily identified. Fruits turn color at normal time but develop red pigmentation slowly and never assume as deep a color regardless of time retained on the plant or in storage. Fruit also retain the texture and low sugar content of mature green fruit.

To facilitate descriptive physiological and biochemical studies of the ripening mutants, isogenic stocks of each mutant have been developed at Purdue University. Such stocks have proven indispensable for precise comparisons of the timing and nature of ripening changes in normal and mutant fruit. The ultimate objective of this work has been to determine the mode of action of each gene in regulating the independent processes which constitute ripening.

Work to date has provided a relatively complete picture of the descriptive physiology of the mutants, however, several questions remain on their mode of action in the regulation and synchronization of ripening. At what point in time during fruit development and/or maturation are these genes first expressed? How does a single gene regulate so many apparently independent processes? What is the primary genetic event involved which affects such diverse changes as fruit softening, carotenoid biosynthesis, ethylene production and respiratory control? Do other genes exist which separately regulate these independent processes of ripening?

Answers to these questions are currently being sought using isogenic stocks heterozygous for the ripening genes. Such stocks have proven useful because of the distinctive effects of each gene in the heterozygous condition on the individual processes of ripening. Hopefully, such studies will ultimately identify the genetically controlled event which alters ripening rate in heterozygotes and essentially inhibits ripening in homozygous fruit.

A potential practical application of the ripening mutants has become evident from studies of ripening mutant effects on fruit shelf life. Hybrids involving the nor mutant ripen acceptably but exhibit a remarkably longer shelf life.

Genetic analysis coupled with detailed physiological studies have provided new insights into the nature, mechanisms, and control of tomato ripening. Further searches are required to identify other genetic factors involved in regulating this vital process. Such mutants will permit further dissection of the ripening process into its component parts to provide a more complete system to study the genetic and physiological control of this dramatic and essential process in fruit development.

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Literature Cited