California Avocado Society 1966 Yearbook 50: 107-111

CYTOLOGY OF THE AVOCADO PERICARP CELL

C. A. Schroeder
University of California, Los Angeles

The avocado fruit is somewhat unique among common fruits in that the major chemical constituent of the mature fleshy fruit tissue is oil. It is comparable to the olive in which the oil is also the major stable product stored in the pericarp cells. Avocado oil is also somewhat different from many vegetable oils in that it does not change to a solid resinous matter when exposed to oxygen and withstands generally the conditions which lead to rancidity in other natural oils. The properties of the oil and the biochemistry of its foundation have been the basis for several investigations which are reported in the literature (1,3).

The structure of the avocado pericarp wall has been described in respect to its gross morphology (2) and more recently in relationship to the fine structure of the several tissues (6). The mesocarp or edible portion consists primarily of homogeneous parenchymatous tissue in which small oil droplets are the major physical constituents. Scattered through the pericarp are specialized oil cells containing the idioblasts which are characterized by large oil sacs. Cells of the latter are lined with a lipid film of suberin-like material and have prominent plasmodesmata inter-connecting with adjacent cells (6). The branched system of vascular strands which traverses the pericarp from stem to apex also is located in the mesocarp.

The oil droplets are found in two distinctive physical conditions and in two types of cells within the pericarp. The small, regular storage parenchyma with an average cell diameter of 60 microns comprise the major storage tissue in which most of the oil occurs as small droplets ranging from 0.5 to 20 or more microns in diameter. These droplets are numerous, and closely packed together, frequently obscuring all other cell constituents. Specialized idioblast cells, somewhat larger in size up to 100 microns in diameter and much fewer in number, are scattered at random through the pericarp parenchyma. These specialized cells contain a prominent large oil droplet consisting of a single spherical mass. The fibrillar structure of these cells has been described previously (6).

While the most obvious major storage constituent of the avocado pericarp is oil in great abundance, there remain other particles of protein nature and cytological structures such as nucleus and plastids which become visible only when the oil droplets are removed by appropriate solvents. The nature and behavior of these cytological constituents is of considerable theoretical interest.

The stimulation which initiates the development of the pistil or ovary of a flower generally results from the process of pollination, followed by union of the pollen and egg nuclei and the subsequent development of an embryo. The general evidence indicates that fruit set in avocado normally does not occur without the sequence of these

processes. Subsequent events following embryo formation consists of the stimulation of cell division activity throughout the ovary wall. This mitotic activity is accompanied by enlargement of cells previously formed and of those currently undergoing division.

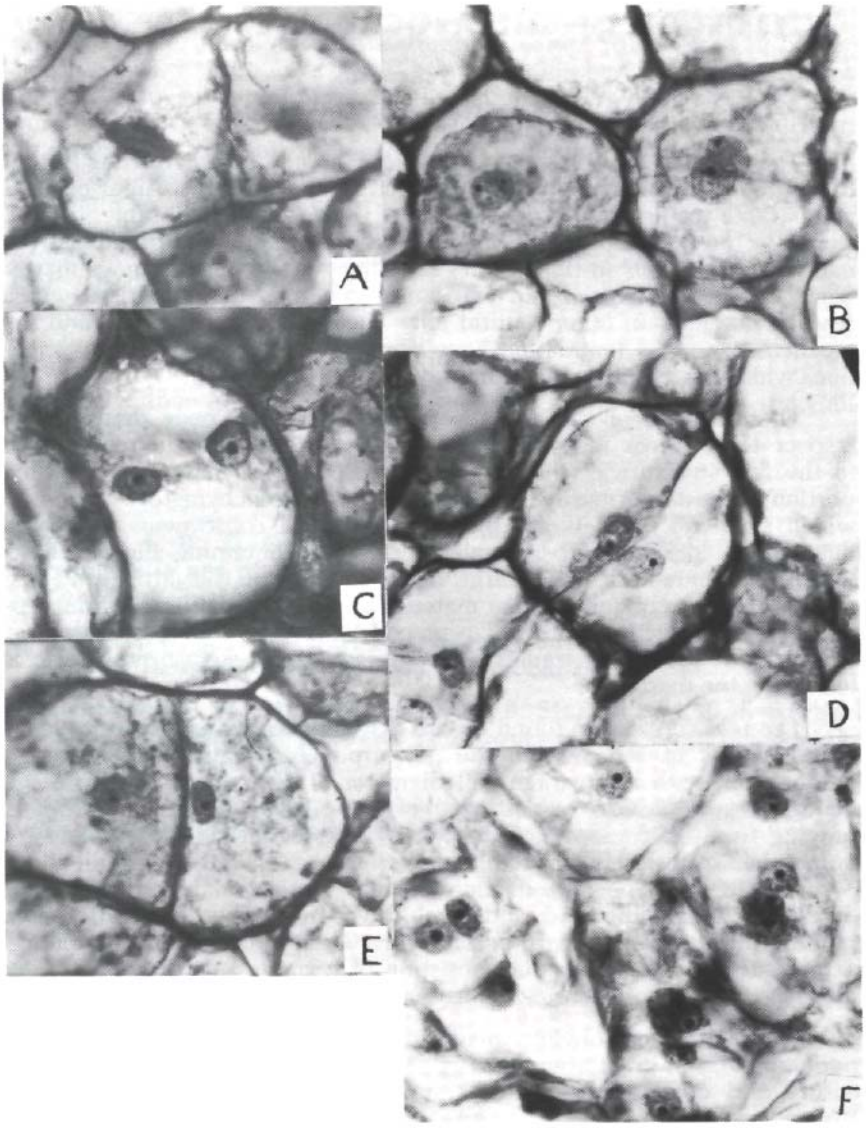

Figure 1.

- **A. Cell in metaphase in mature avocado pericarp.**
- **B. Double nuclei in daughter cells prior to primary wall formation.**
- **C. Double nuclei in daughter cell.**
- **D. Primary wall separating nuclei in newly divided parent cell.**
- **E. Secondary wall bisecting older cell in mature pericarp tissue.**
- **F. Multiple nuclei in mother cells of avocado pericarp induced to rapid mitosis in tissue culture. Primary wall formation not yet apparent.**

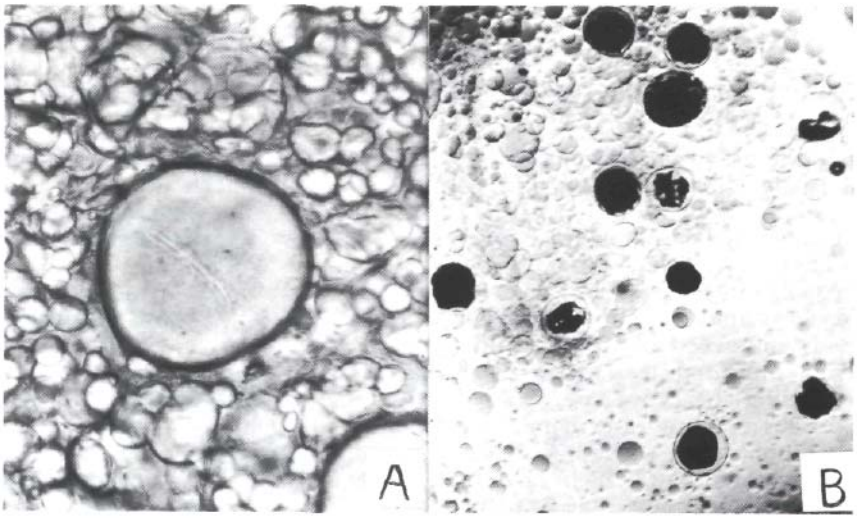

Figure 2.

A. Oil idioblast of avocado showing single large droplet. Note regular oil droplets of small sizes in other pericarp parenchyma.

B. Distribution of specialized oil cells, idioblasts, in soft pericarp tissue, which has been gently crushed by pressure on cover glass. Note intact, resistant cell wall of idioblast and deep staining of oil with iodine and sulfuric acid.

The processes of fruit set and development in other types of fruit such as apple, pear, plum or tomato involves cell division activity in the ovary wall for a period of about three weeks. Cell division then ceases in such fruits and subsequent tissue growth is primarily the result of cell enlargement of those cells previously formed. The avocado, however, differs markedly from this pattern of development in that cell division activity does not stop after three weeks, but is evident in the pericarp tissue from the time of embryo formation through the entire developmental life of the fruit (5). The individual pericarp cells of avocado never become excessively large as, for example, is evident in many cells of apple tissue, but instead attain a given size, approximately 60 microns in diameter, at which time they divide to give rise to two smaller cells which again increase in size to develop mass in the pericarp.

The evidence for continued mitotic activity throughout the period of fruit development has been indicated by direct observation of tissues taken from mature fruit (4). Such materials show recently divided cells which are distinguished by the fact that the newly formed cell wall bisects the mother cell and forms a straight wall at approximately right angles to the original wall. The newly formed wall becomes curved upon rounding up of the daughter cells. Simultaneous increase in adjacent intercellular spaces is noted. Upon attainment of maximum diameter, approximately 60 microns, the new cells again undergo division.

The processes of mitosis involve several sequential stages which result in the condensation of nuclear material and subsequent division of chromosomal constituents into two equal masses which are incorporated into the two daughter cells. The cell wall which develops to separate the two daughter nuclei frequently forms at a late period in the sequential development, thus many cells which are in the later stage of mitotic

activity frequently appear to contain two nuclei.

The occurrence of double nuclei is not common in plant cells though it is not entirely unique. The occurrence of two nuclei per cell is not regularly observed in most fruit tissues. The tendency toward the rapid division of nuclear materials and the comparatively slower formation of primary wall which presents the condition of double nuclei has been demonstrated in studies of pieces of avocado pericarp tissue cultured in vitro under carefully controlled conditions (4). Several investigations on avocado pericarp utilizing the techniques of tissue culture have indicated the potentiality of this issue to provide information regarding the processes of cell division and cellular physiology. When portions of tissue are maintained on nutrient agar media under sterile conditions, it is possible to induce mitotic activity to various degrees. Under conditions which favor cell division there is the frequent appearance of double nuclei in the rapidly dividing cells. Occasionally, there are several nuclei within a given mother cell before the appearance of new cell walls to separate the daughter nuclei. This multi-nucleate condition prevails only for a short period and is followed by formation of the primary walls.

LITERATURE CITED

1. Barton. E. J. Squires. C. and Stumpf, P. K. Fat metabolism in higher plants XV. Enzymic synthesis of fatty acids by an extract of avocado mesocarp. Jour. Biol. Chem. 236(101:2610-2614.1961.
2. Cummings. Katherine and Schroeder. C. A. Anatomy of the avocado fruit. Calif. Avocado Soc. Yearbook. 27:56-64. 1942.
3. Overath, P. and Stumpf. P. K. Fat metabolism in higher plants XXIII. Properties of a soluble fatty acid synthetase from avocado mesocarp. Jour. Biol. Chem. 239(12):4103-4110. 1964.
4. Schroeder. C. A. Growth and development of the Fuerte avocado fruit. Proc. Amer. Soc. Hort. Sci. 61:103-109. 1953.
5. Scott, F. M., Bystrom. B. G. & Bowler, E. Persea americana, mesocarp cell structure, light and election microscope study. Bot. Gaz. 124:423-428.1963.
6. Schroeder, C. A, Some morphological aspects of fruit tissue grown in vitro. Bot. Gaz. 112:198-204. 1961.