OPTIMIZING PROTOCOLS FOR GROWING COTTON OVULE CULTURES IN MICROGRAVITY ABOARD THE INTERNATIONAL SPACE STATION

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Abstract

The ability to grow plants in space is central to NASA's plan for providing a "controlled ecological life support system" for humans during extended space missions. After over a decade of attempts to grow plants in microgravity, it is clear that many physiological processes are altered in this environment. Cell wall formation, cellulose biosynthesis, and carbohydrate metabolism have all been shown to be altered in space-grown plants. The cotton ovule culture system of Beasley and Ting (1973) is an especially well-suited experimental system for evaluating the effects of altered gravity environments on cell wall growth and development. Another advantage of the cotton ovule culture system is that embryo development can also be followed if fertilized ovules are used for initiating the cultures. In this report, we have added various gelling agents to culture media and observed the effects on fiber and ovule development. Four gelling agents (agar, agarose, Phytagel, and Phytagar) were compared in this study at several different concentrations. Cultures in which agar and agarose had been added resulted in callus production. Adding 0.15% Phytagel to Beasley-Ting media resulted in cultures that contained no callus and produced fiber in amounts similar to liquid media cultures when evaluated with the Toluidine Blue 0 staining method. More detailed evaluation of the cultures after three weeks revealed that fiber length was not affected, however, ovule mass and fiber cellulose content was reduced on the solid medium. By continuing the culture period for one or two more weeks, ovule cultures on solid media produced fiber that contained nearly the same amount of cellulose as cultures grown on liquid media. With the optimization of culture conditions that can withstand the hypergravity effects of lift-off (2 x g) as well as microgravity conditions, we are ready to evaluate the effects of altered gravity on specific aspects of fiber development. We anticipate that by using morphological, biochemical, and molecular markers of fiber development in altered gravity experiments we will gain new information about the processes that control normal fiber production on earth.

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