CHAPTER 2

Effect of Water Potential on Microbial Growth and Activity

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INTRODUCTION

Microbial tolerance to water stress varies widely, in general showing little relationship to classical taxonomy (Tables 1, 2). The mechanistic basis of microbial water relations has received increasing attention since Scott’s (1957) classic water activity-based review, particularly in the areas of extreme xerotolerance (Brown, 1976, 1978; Rose, 1976; Dundas, 1977; Lanyi, 1978), food spoilage (Pitt, 1975; Leistner and Rodel, 1976), wood decay (Griffin, 1977), and the water relations of soil fungi and soil-borne pathogens (Griffin, 1969, 1978). In addition, a recent Dahlem workshop on “Life at low water activities” had a strong microbial orientation (Shilo, 1979). Current theories on mechanisms of water stress resistance by higher and lower plants, with particular emphasis on the role of turgor pressure, are reviewed by Hsiao et al. (1976).

Major recent advances in the biophysics and biochemistry of extreme xerotolerance have led to the introduction of the concept of compatible solutes, and of its extension as a general mechanism of intracellular water control to nonxerotolerant as well as xerotolerant microorganisms (Brown, 1976, 1978). Similarly, the chemiosmotic basis of energy coupling by Halobacterium halobium (Lanyi, 1978) has general implications regarding osmoregulation mechanisms used by non-photosynthetic as well as photosynthetic microorganisms under water stress.

Water activity (A_w) is still the most widely used parameter for characterizing microbial water relations (Brown, 1978), although the powerful mechanistic advantage of the additive nature of water potential (ψ) is gaining increasing recognition by microbiologists (Adebayo et al., 1971; Griffin, 1978).

This review evaluates the water potential relations of microorganisms in terms of compatible solute and energetic concepts of microbial growth under water stress. Particular emphasis is placed on physiological characterization of the different mechanistic strategies used.