CHAPTER 6

CARBOHYDRATES AND FORAGE QUALITY

K. J. Moore and R. D. Hatfield

INTRODUCTION

Carbohydrates are the most abundant class of compounds found in plants. They account for 50-80% of the dry biomass of forage species (Van Soest, 1982). From a plant perspective, carbohydrates play important roles in intermediary metabolism, energy transfer and storage, and plant structure. Photosynthetic energy is fixed in carbohydrates via the Calvin cycle and these carbohydrates serve as initial substrates for nearly all intermediary pathways in plants. Energy is translocated within plants as the disaccharide sucrose (Hawker, 1985), and stored in polymers such as starch and fructans (Manners, 1985; Pontis and Dél Campillo, 1985). Carbohydrates constitute most of the plant cell wall and therefore play an important role in the structural integrity of individual cells, tissues, and organs (Hatfield, 1989).

Carbohydrates are extremely important from a nutritional perspective, providing the primary source of energy in ruminant diets. In ruminants, nearly all carbohydrate digestion (>90%) occurs within the rumen (Armstrong and Smithard, 1979; Sutton, 1979), although under certain circumstances, such as high rates of passage, a significant amount of carbohydrate digestion can occur in the small and large intestines (Hoover, 1978; Nocek and Tamminga, 1991). Simple sugars are rapidly fermented within the rumen to yield volatile fatty acids which are absorbed into the blood through the rumen wall (Morrison, 1979; Baldwin and Allison, 1983). Polysaccharides must be degraded to simple sugars before being utilized. Nonstructural polysaccharides, such as starch and fructans, are rapidly and generally completely degraded within the rumen (Nocek and Tamminga, 1991), while degradability of structural polysaccharides varies considerably. Pectins are rapidly and essentially completely degraded by ruminal microbes (Hatfield, 1989, 1993a). Cellulose and hemicellulosic polysaccharides are more slowly and incompletely degraded. Cellulose degradability of forages varies from 25-90% while hemicellulose digestibility varies from 45-90% (Pigden and Heaney, 1969). Degradation of β-glucans is intermediate to that of pectins and cellulose (Van Soest et al., 1991). This ability to degrade and utilize structural carbohydrates confers upon ruminants their unique ecological niche (Chesson and Forsberg, 1988).