

14.8: Feedstocks from Cellulose Wastes

Large quantities of cellulose-rich waste biomass are generated as byproducts of crop production in the form of straw remaining from grain harvest, bagasse residue from the extraction of sucrose from sugar cane, and other plant residues. This biomass represents a large amount of essentially free raw material that potentially can be converted to valuable chemical feedstocks. One way in which this can be done is by the use of enzyme systems to break the cellulose down into glucose sugar used directly as a feedstock or fermented to produce ethanol. Direct conversion of cellulose wastes to feedstocks is another route. Fortunately, nature has provided efficient microorganisms for this purpose in the form of rumen bacteria that live in the stomachs of cattle and related ruminant animals. It has been found that these bacteria function well in large fermenters from which oxygen is excluded if the plant residues are first treated with lime (chemical formulas $\text{Ca}(\text{OH})_2$ and CaCO_3), producing short-chain organic acids that exist as their calcium salts in the presence of lime.

The organic acids produced by rumen bacteria in animals that can use cellulose as food are absorbed from the digestive systems of the animals and used as food. The acids produced in fermenters are in the form of calcium salts, the main ones of which consist of calcium acetate, calcium propionate, and calcium butyrate. These calcium salts of organic acids can be processed in several ways to produce feedstocks for a variety of organic syntheses. As shown in Figure 14.6, acidification of the salts yields the corresponding organic acids. Reaction of these acids with elemental hydrogen (hydrogenation) can be used to convert them to alcohols. Heat treatment (pyrolysis) of the calcium salts of the organic acids at 450°C produces ketones, such as those shown in Figure 14.6. These compounds are valuable feedstocks for a number of different chemical synthesis operations.

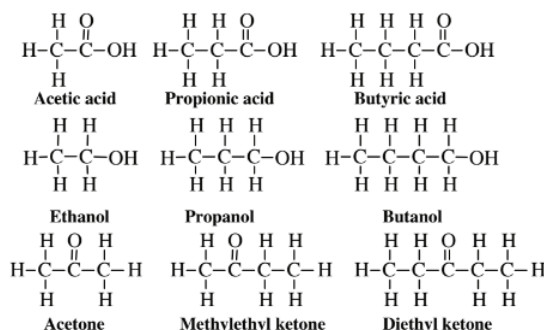


Figure 14.6. Production of organic chemicals from cellulose beginning with its breakdown by bacteria isolated from the rumen in animals capable of digesting cellulose. The first products are carboxylic acids, which can be converted to alcohols by hydrogenation and to ketones by pyrolysis

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