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Utilization of Glucoisosaccharinic Acid and Components of Kraft Black Liquor as Energy Sources for Growth of Anaerobic Bacteria

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Summary

It is shown that alpha-glucoisosaccharinic acid, one of a family of modified and partly oxidized sugar derivatives ("aliphatic acids") present in kraft pulp mill "black liquor" (KBL) as a consequence of degradation of carbohydrates under alkaline conditions at elevated temperature, will serve almost as effectively as glucose as a source of energy for anaerobic bacterial growth, and for supporting the biological destruction of chlorinated lignin derivatives. The aliphatic acids in KBL itself are found to have similar capabilities. The results suggest that the these constituents of KBL may be useful as an energy source for anaerobic bacteria effective in destruction of chlorolignins in the effluent streams of kraft pulp mill bleach plants.

Introduction

To remove chlorolignins from the effluents of wood pulp bleaching plants, biological processes such as aerated stabilization basins, activated sludge, anaerobic and also fungi treatments have been studied. In pulp bleaching effluents, biodegradable organic compounds may not be present in sufficient amounts to support growth of anaerobic microorganisms or fungi in order to provide for the removal of chlorolignins, the degradation of which may not yield useful energy for the bacteria. Thus such compounds as sugars, methanol and acetic acid have been added to serve as supplementary energy sources in studies of anaerobic (Ferguson *et al.* 1990) and fungi treatments (Joyce *et al.* 1988).

A major stream arising in the kraft pulping and recovery process is "kraft black liquor", (KBL), which contains organic solutes consisting mainly of kraft lignin, (KL), polysaccharide degradation products, as well as aliphatic carboxylic acids and smaller amounts of extractive components as discussed by Sjöström (1981).

The composition of a typical KBL (20% total solids; about pH 11) from pine (Marton 1971), as percent of total solids, is as follows: alkali lignins (including soluble phenols), 41; extractives (fatty and rosin acids), 3; hydroxy acids and lactones, 28; acetic acid, 5; formic acid, 3; sulfur,3; and sodium 16.

The organic components have significant energy and possibly chemical values, and KBL can be fractionated to deplete the lignin and/or inorganic salts and, at the same time, to concentrate the aliphatic acids which should be biodegradable.

Thus Alén and Sjöström (1980) processed KBL by a series of steps including evaporation, carbonation, acidic precipitation, distillation and sodium sulfate crystalization. Thereby, they accomplished separation of most of the lignin, inorganic salts, volatile gases and water. A syrupy crude aliphatic or hydroxy acid fraction was recovered which contained, expressed as weight percent of total solids, about 65, 17 and 18 of alphatic acids, lignin, and other organic and inorganic compounds, respectively. The estimated mass ratio of organic to inorganic material was reported to be 4.5; the sodium content was less than three percent of the dry solids.

Certain aliphatic acids in this fraction were identified by Alén and Sjöström (1980). Table 1 shows the nature and also the proportion of these components as percentages of KBL solids. Additional results have been reported by the same authors and their coworkers, (1986, 1987).

Bailey and Linko (1987) also prepared and aqueous solution enriched in aliphatic acids and depleted in lignin. Their procedure involved acidification of KBL to pH 4 with phosphoric acid, heating to precipitate higher molecular weight lignins and then centrifuging to remove the precipitate. The composition of the resulting solution was not reported.