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GREEN CHEMISTRY PROSPECTS OF GLYCOLIC ACID ESTERS: SYNTHESIS AND APPLICATIONS

Research into glycolic acid is attracting more and more attention because it can be used both in everyday life and in industry. It also serves as a basis for developing new materials and technologies and is used in the food, pharmaceutical, metallurgical, cosmetic and textile industries, which indicates its considerable versatility.

Of particular interest is its use in green chemistry, which is gaining popularity due to its biodegradability, adaptability and low toxicity.

In reality, glycolic acid is a naturally occurring substance, meaning that plants naturally produce it and may be found in nature. During photosynthesis, it is formed. Blends of glycolic acid are made by the extraction of plant materials but may be standardized by the addition of man-made chemicals. Petroleum and renewable resources, such as sugar cane, sugar beets, pineapple, oranges and grapes, can provide glycolic acid [1, p. 63].

Glycolic acid can be produced artificially through various methods: chemical synthesis, microbial fermentation, and enzymatic conversion are the main processes used for its production. One such method is CO2 hydrogenation to methanol, as described by the reaction: $CO2 + 3H2 \rightleftharpoons CH3OH + H2O$ followed by the catalytic oxidation of methanol to formaldehyde: $CH3OH \rightarrow CH2O + H2$ and finally, the carbonylation of formaldehyde to glycolic acid: $CH2O + H2O + CO \rightarrow HOCH2COOH$ [2, p. 7].

Fermentation is a straightforward biological process for using microorganisms to produce potent, high-purity glycolic acid compounds. Making wine or beer is comparable, but the microbes create glycolic acid rather than alcohol.

Enzymatic conversion is another method of obtaining glycolic acid and is facilitated by certain chemo-lithotrophic iron and sulfur-oxidizing bacteria or Alcaligenes sp. Nitrilase enzyme activity hydrolyses glycolinitrile to create glycolic acid naturally.

Purification methods play an essential role in obtaining high-quality glycolic acid. Crude glycolic acid is purified through distillation, crystallization, ion exchange, and activated carbon treatment.

In its purified form, glycolic acid is a member of the class of tiny compounds that can have a variety of intramolecular hydrogen bonding conformations. Hydrogen bonding between the carbonyl oxygen and the hydroxyl proton is the lowest energy structure experimentally determined.

The tiny acid molecule reduces corneocyte adhesion and can penetrate the epidermis outermost layer. It simply indicates that glycolic acid aids in the removal of the matrix that holds the dead cells on the epidermis outermost layer together. When these dead cells begin to decompose, it stimulates the renewal of new skin cells. These new skin cells give a fresh, youthful look to the skin.

Glycolic acid is used in many different sectors, primarily for pH control or when a cheap organic acid is required. Because of its antibacterial qualities and tendency to not corrode, it is frequently used in acidic cleaning solutions. In particular, it prevents the development of microorganisms that oxidize iron. In addition, glycolic acid is used to purify water and remove scale and rust from pipes and heat exchangers [1, p 63]. Moreover, it is employed in fur processing and in the textile sector for crease-proofing, printing and textile dyeing [2, p. 2].

Esters of glycolic acid are synthesized through esterification. With the formula CH2OHCOOR, glycolic acid esters – also referred to as hydroxyl acetic acid esters and ethanolic acid esters are typically made by esterifying glycolic acid with alcohol (HOCH2COOH + ROH). An example of such an ester is methyl glycolate, which is synthesized through dimethyl oxalate hydrogenation over Cu-Ag/SiO2 catalysts.

Glycolic acid esters are widely used in pharmaceuticals as prodrugs, solubility enhancers, permeation enhancers, and cosmetics such as skin care products, moisturizers, and exfoliants. They are also used in agriculture as plant growth regulators, insecticides, and herbicides.

Thus, glycolic acid is essential in daily life and industrial processes. It can be sustainably produced using green chemistry approaches, and esters of glycolic acid hold great potential for medical, agricultural, and polymer applications.

REFERENCE

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