WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review on Chemistry of Glycolic Acid and its Similar Analogue

Aman Mundhe [1], Mr. Ganesh Gophane [2], Dr. Vijaysinh Sable[3], Dr Rani Mhetre[4]

UG Student[1], Guide[2], Principle[3], Vice Principle[4]
[1,2,3,4]Lokmangal College of Pharmacy, Wadala

ABSTRACT

A small α-hydroxy acid (AHA), glycolic acid has drawn a lot of interest in a variety of fields, especially dermatology, cosmetics, and biomedical applications. Because of its distinct chemical makeup, it has anti-aging, hydrating, and exfoliating qualities, which makes it a vital component of skincare products. By encouraging collagen synthesis and increasing cell turnover ., glycolic acid is also used in chemical peeling operations to improve skin tone and texture. Because of its varied reactivity, glycolic acid finds use in industrial operations beyond dermatology, including chemical production and textile treatment. This work aims to provide a comprehensive analysis of the synthesis, characteristics, various uses, chemistry, and analogue of glycolic acid.

Keywords : Glycolic Acid,Chemical Identity, Physical and chemical properties of Glycolic Acid ,Analogue of Glycolic Acid

Introduction :

Out of all the alpha-hydroxy acids, GA has the shortest molecular weight. It is a well-liked peel agent since it easily penetrates skin.Two carbon atoms make up GA: one has a carboxyl group, while the other has a hydroxyl group. GA has a high hydrophilicity. A non-buffered solution's pH falls between 0.08 and 2.75.Because buffered or partially neutralized GA is safer than free GA, previous authors have advised using it.Peels of glycolic acid can be bought commercially as free acids, buffered, esterified, or partially neutralized (higher pH) solutions.They are offered in a range of concentrations, from 20% to 70%. The intensity of the peeling increases with concentration and decreases with pH.7

Both commercial and household uses for glycolic acid, which is made by chemical synthesis or plant extraction, take advantage of its acidity and capacity to break up encrustations.

The absorption of glycolic acid occurs through the skin, inhalation, and ingestion. Large amounts of it are metabolized to glyoxylic and oxalic acids in humans, which are likewise eliminated in the urine, but the majority are eliminated unaltered.

Human metabolic acidosis and renal failure linked to ethylene glycol poisoning are directly caused by glycolic acid, a byproduct of ethylene glycol. In human tolerability trials, glycolic acid-containing cosmetic compositions have been thoroughly examined.

Although there is no proof of contact sensitization, glycolic acid irritates the skin and induces stinging in a way that is dependent on pH and/or dose. In tests using products containing 0.5% to 50% glycolic acid at pH 1.2 to 5.5, 10% of participants reported stinging, and 13% of participants showed symptoms of skin irritation. According to one study, some people's skin Up to 50% more people were susceptible to sunburn when glycolic acid was present .

Name of chemical (IUPAC) Acid hydroxyethanoic

Additional names

hydroxy-alpha-hydroxyacetic acid with acetic acid Gluco-hydroxy acid

The approved Australian name for glycolic acid Acid hydroxyacetic

2. Acid hydroxyacetic

Numbers for the registry

According to the Australian Inventory of Chemical Substances (AICS), glycolic acid is classified

as hydroxyethanoic Acid

EINECS number 201-180-5, RTECS number MC5250000, and CAS number 79-14-1

Molecular formula

C2H4O3

Molecular weight

76.05

units of concentration

The amount of glycolic acid in cosmetic products is often expressed as a percentage of

weight/weight. Consequently, 10 mg/g of glycolic acid is present in a 1% solution, gel, cream, or

lotion composition. A 1 M solution contains 7.6% (76 mg/mL) of glycolic acid.

Structural formula

H O

| ||

HO—C—C—OH

| H

Chemical properties

Alpha-hydroxy acid (AHA) that dissolves in water and has both reducing and acidic qualities isglycolic acid ($C_2H_4O_3$). It contains a carboxyl group (-COOH) that can react with alcohols togenerate glycolate esters through esterification. Its moderate acidity causes it to dissociatewater-based solutions, producing hydrogen ions (H^+) and contributing to the exfoliating qualitiesOf Skincare products. Additionally, glycolic acid can create salts like sodium glycolate by takingpart in neutralization reactions with bases. It can be used as a chemical peeling agent and incosmetic compositions due to its reactivity. It also has also reducing qualities that can influence other organic molecules in different kinds of reactions.

Physical properties

Glycolic acid, a minor organic alpha-hydroxy acid (AHA) with the following essential physicochemical characteristics, has the chemical formula $C_2H_4O_3$.

1. crystaline,odourless,colourless and somewhat hydroscopic solid are the characteristics of Glycolic Acid (Budvari 1996)
2. Weight in molecules: 76.05 g/mol.
3. Melting Point: 78-80°c (Miltenberger 1989)
4. Boiling Point: 100°c (decomposes above temperature) 112°c (70%solution) (DuPont 1998e)
5. Partition Coefficient : -1.38.(Barratt (1996)) . -1.11 (hansch and Leo 1987)
6. Refractive Index (at 20°C): 1.445–1.448
7. acidic nature gives it a subtle, sour smell.

Synthesis of Glycolic Acid

Glycolic acid ($HOCH_2COOH$), sometimes referred to as hydroxyacetic acid, can be made in a number of ways. The following are a few of the main synthetic routes

1. The process of hydrolysing glycoaldehyde
2. The process of ethylene glycol oxidation
3. Direct Glycolic Ester Hydrolysis
4. Glycolic Acid Reduction
5. Fermentation Biological Synthesis

1. The process of hydrolysing glycoaldehyde

Glycolaldehyde, an intermediate in a number of organic reactions, may be hydrolyzed to generate glycolic acid, making it one of the simplest processes.

. The steps in this procedure are as follows:

The starting material is $HOCH_2CHO$ (glycolaldehyde).

Glycolic acid is produced when glycoldehyde is hydrolyzed, typically with water present and under mildly basic or acidic conditions.

Reaction

$HOCH_2CHO + H_2O \rightarrow HOCH_2COOH$

2. The process of ethylene glycol oxidation

The oxidation of ethylene glycol (EG), a simple diol, is another popular technique. Under carefully monitored circumstances, ethylene glycol is converted to glycolic acid.

The initial substance is ethylene glycol ($HOCH_2CH_2OH$).

Reagents: Mild oxidizers such nitric acid (HNO_3), potassium permanganate ($KMnO_4$), or other oxidizing agents.

Glycol oxidation and the breaking of the carbon-carbon bond are common steps in this process.

3. Direct Glycolic Esters Hydrolys

It is possible to hydrolyze glycolic esters, like methyl or ethyl glycolate, to produce glycolic acid.In industrial settings, this technique is frequently employed for large-scale manufacturing.

Beginning Material: Glycolic esters such as methyl glycolate (CH_3OCH_2COOH).

Reagents: Aqueous acid/base or water

Glycolic acid and alcohol are released when the ester hydrolyzes in this situation.

$RCOOCH_2OH + H_2O \rightarrow HOCH_2COOH + ROH$

4. Glyoxylic Acid Reduction

Using a reducing agent, glycolic acid can be produced from glycolic acid (HOCHOCOOH).

Glyoxylic acid (HOCHOCOOH) is the starting material. Reagents: A reducing agent, like sodium borohydride ($NaBH_4$).

This process creates glycolic acid by reducing the carbonyl group in glyoxylic aciid to a hydroxyl group

$HOCHOCOOH + NaBH_4 \rightarrow HOCH_2COOH$

5. Fermentation–Biological Synthesis

Additionally, microbial fermentation can be used to create glycolic acid. Glycolic acid-producing bacteria are among the microorganisms that can anaerobically convert carbohydrates like glucose or glycerol into glycolic acid.

Initial Ingredient: Simple sugars (glycerol, glucose)Organisms include bacteria such as Enterobacter aerogenes and strains of modified yeast.

This approach, which is more ecologically friendly, is being investigated for large-scale manufacturing, especially for bio-based synthesis

In brief:

The hydrolysis of glycolic esters or glycolaldehyde provides a simple production pathway.

Another efficient technique is the oxidation of ethylene glycol.

Although they might be more complicated for industrial scale, biological approaches provide a sustainable pathway.

The intended production volume, cost-effectiveness, and reagent availability all influence the technique selection.

Application of Glycolic Acid

In processed foods, drinks, and sauces, glycolic acid serves as an acidulant, a preservative,and a pH regulator. I

In the agricultural sector, glycolic acid is employed as a mild herbicide or fungicide and in pesticide formulations to increase solubility and efficacy. It also helps to maintain pH balance of agricultural goods and soil

Analogue of Glycolic Acid

Analogue design is usually defied as the modification of drug molecule or.of any bioactive ingredient to create a novel molecule exhibiting chemical and biological similarity with the original model compound

Following are the analogue of Glycolic Acid

Mallic Acid

The chemical formula for malic acid is $C_4H_6O_5$, and it is an organic molecule that occurs naturally.

Many fruits, particularly apples, contain this dicarboxylic acid, which gives them their acidic flavor.

In The Krebs cycle, sometimes referred to as the citric acid cycle, is necessary for cells to generate energy malic acid plays a significant function in the metabolic activities of living things. It is frequently added to cuisine to improve flavor and acidity, and because of its exfoliating qualities, it can also be included in some skincare products

Lactic acid.

The chemical formula for lactic acid is $C_3H_6O_3$, making it an organic acid. It is a result of the fermentation of carbohydrates and is created in the body during anaerobic respiration, which occurs when oxygen levels are low, as occurs during vigorous physical activity. The burning Lactic acid produces feeling in muscles during vigorous exercise.It is present in a range of foods foods, but it adds to the sour flavor of fermented foods like yogurt, kefir, and sauerkraut. Additionally, lactic acid finds industrial use in pharmaceuticals, cosmetics, and food preservation. Its naturally occurring forms are L-lactic acid and D-lactic acid..

Citric acid

With the chemical formula $C_6H_8O_7$, citric acid is an organic acid that occurs naturally. Citrus fruits like lemons, limes, and oranges are the most typical places to find it, as it adds to their distinctively sour flavor. A weak acid, citric acid is used as a flavoring, preservative, and acidulant in the food and beverage industry. cycle, commonly known as the Krebs cycle, which is a major metabolic route that helps cells produce energy. Citric acid's chelating and pH-adjusting qualities also make it a common ingredient in cleaning supplies, cosmetics, and medications.It is also crucial to use citric acid

Tartaric Acid

Many plants, most notably grapes, contain tartaric acid, a naturally occurring organic acid. It is an essential part in making wine because it stabilizes the fermentation process and adds to the wine's sour flavor. Because of its acidulant qualities, tartaric acid can be used as a food additive (E334), in baking (as cream of tartar, a result of winemaking), and in cosmetics and medications for its stabilizing and antioxidant qualities. It is furthermore employed in the textile industry and in the manufacturing certain compounds. Its formula is $C_4H_6O_6$, which indicates that it is of a dihydroxy dicarboxylic acid.

Boiling point : 275°c

Melting point : 171°c to 174°c Density : 1.79 g/ml

Molecular weight :150.087 g/mol

Mandelic Acid :

Bitter almonds are the source of the alpha-hydroxy acid (AHA) known as mandelic acid. It is a mild exfoliator used in skincare products to get rid of dead skin cells and make skin smoother and more radiant. Mandelic acid is less irritating and more suited for sensitive or acne-prone skin because of its bigger molecular size, which allows it to permeate the skin more slowly than other AHAs like glycolic acid. It improves skin texture, lessens hyperpigmentation (darkspots), and unclogs pores to help treat acne. Mandelic acid is also useful for treating acne and improving the appearance of skin because it possesses mild antibacterial and anti-inflammatory qualities Mandelic acid has the chemical formula C8H8O4.

It includes:

Eight atoms of carbon (C) Eight atoms of hydrogen (H) Four atoms of oxygen (O)

A carboxyl group (-COOH) and a hydroxymethyl group (-CH2OH) are joined to an aromatic benzene ring in this structure.

Conclusion :

A very adaptable substance, glycolic acid and its analog have many uses in the chemical,pharmaceutical, and cosmetics sectors.Their ability to react chemically, especially when both hydroxyl and carboxyl groups are present, makes them useful for a variety of activities, including polymer formation and esterification. friendly production techniques and novel applications will probably increase their significance in contemporary industries.

References

1. Landau M. Chemical peels. Clin Dermatol. 2008;26(2):200–208.
2. Roberts WE. Chemical peeling in ethnic/dark skin. Dermatol Ther. 2004;17(2):196–205.
3. Becker FF, Langford FP, Rubin MG, Speelman P. A histological comparison of 50% and 70% glycolic acid peels using solutions with various pHs. Dermatol Surg. 1996;22(5):463–465.
4. Ditre CM. Glycolic acid peels. Dermatol Ther. 2000;13(2):165–172.

5. Fischer TC, Perosino E, Poli F, Viera MS, Dreno B; Cosmetic Dermatology European Expert Group. Chemical peels in aesthetic dermatology: an update 2009. J Eur Acad Dermatol Venereol. 2010;24(3): 281–29

6. Fabbrocini G, De Padova MP, Tosti A. Chemical peels: what’s new and what isn’t new but still works well. Facial Plast Surg. 2009;25(5): 329–336. 7.Zouboulis, C. C., & Kligman, A. M. (2009). Alpha hydroxy acids in dermatology.Dermatologic Therapy, 22(5), 374-381.

7. Budavari S (1996) The Merck Index, 12th ed. Whitehouse Station, NJ, Merck & Co., Inc

8. Miltenberger K (1989) Hydroxycarboxylic acids, aliphatic. In Elvers B, ed. Ullmann’s encyclopedia of industrial chemistry. Weinheim, VCH Verlagsgesellschaft, vol. A13, pp 507-511

9. DuPont (1998e) Glycolic acid: Properties, uses, storage and handling. Belle, WV, DuPont Specialty Chemicals.

10. Barratt MD (1996) Quantitative structure-activity relationships (QSARs for skin corrosivity of.organic acids, bases and phenols: Principal components and neural network analysis of extended datasets. Toxicology in Vitro, 10:85-94.

11. Hansch C, Leo A (1987) The logP database. Claremont, CA, Pomona College

.