

ORGANIC ACIDS AND THEIR CHEMICAL REACTIONS: STRUCTURE, FUNCTION, AND APPLICATIONS

Khamidova Aziza

Academic Lyceum of Tashkent Pharmaceutical Institute

Abstract: *Organic acids are a fundamental class of organic compounds that play crucial roles in biological systems, industry, and the environment. Characterized by the presence of one or more carboxylic acid groups (-COOH), these acids participate in numerous chemical reactions, including acid-base neutralization, esterification, oxidation, and decarboxylation. This article discusses the nature, classification, and major chemical reactions of organic acids, with examples and relevant equations, emphasizing their importance in both scientific and practical contexts.*

Keywords: *ethanol, oxygen, acetic acid, sodium hydroxide, organic acid, amino acid, vinegar.*

INTRODUCTION

Organic acids are weak acids that contain carbon atoms and typically include a carboxyl group (-COOH). Unlike strong mineral acids, organic acids are only partially ionized in solution and are often found naturally in foods, living organisms, and metabolic pathways. Acetic acid (vinegar), citric acid (found in citrus fruits), and lactic acid (produced in muscle metabolism) are common examples.

2. Structure and Classification

Most organic acids are carboxylic acids, meaning they contain one or more carboxyl groups. They are classified as follows:

- Monocarboxylic acids: Contain one -COOH group (e.g., formic acid, CH₂O₂).
- Dicarboxylic acids: Contain two -COOH groups (e.g., oxalic acid, C₂H₂O₄).
- Hydroxy acids: Have both hydroxyl (-OH) and carboxyl groups (e.g., lactic acid).
- Amino acids: Contain both amino (-NH₂) and carboxyl groups, essential in proteins.

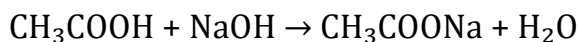
3. Key Chemical Reactions of Organic Acids

Organic acids undergo several characteristic reactions. Below are major types of reactions with equations and explanations.

3.1. Acid-Base Neutralization

Organic acids neutralize bases to form salts and water. This is one of their most fundamental chemical behaviors.

Example:

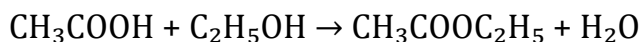


Acetic acid + Sodium hydroxide → Sodium acetate + Water

3.2. Esterification

When an organic acid reacts with an alcohol in the presence of an acid catalyst, an ester and water are formed.

Example:



Acetic acid + Ethanol → Ethyl acetate + Water

This reaction is reversible and used in fragrance and plasticizer industries.

3.3. Oxidation of Alcohols to Acids

Primary alcohols can be oxidized to carboxylic acids using oxidizing agents such as potassium permanganate (KMnO_4).

Example:



Ethanol + Oxygen → Acetic acid

3.4. Decarboxylation

Carboxylic acids lose a carbon dioxide molecule when heated or in the presence of a catalyst, particularly dicarboxylic acids.

Example:

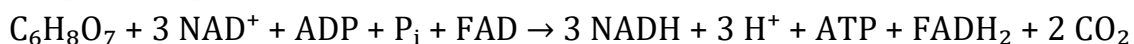


Oxalic acid → Carbon dioxide + Formic acid

3.5. Participation in Metabolic Cycles

Citric acid plays a major role in the Krebs (Citric Acid) Cycle, a central metabolic pathway in aerobic organisms.

Simplified equation:



This demonstrates the role of organic acids in producing energy within cells.

4. Applications of Organic Acids

Organic acids are widely used due to their chemical reactivity and biological relevance:

- Food preservation: Benzoic and sorbic acids inhibit microbial growth.
- Agriculture: Formic and propionic acids are used in silage treatment.
- Medicine: Salicylic acid is used in acne treatment and aspirin production.
- Industry: Acetic acid is used in plastics and textile industries.

5. Environmental and Biochemical Importance

Unlike many synthetic chemicals, organic acids are biodegradable and less harmful to the environment. Their roles in photosynthesis, respiration, and fermentation highlight their essential function in life processes.

6. Conclusion

Organic acids are versatile compounds integral to both nature and industry.

Their distinct chemical behavior, particularly their ability to undergo esterification, oxidation, and neutralization, makes them valuable in a broad range of fields. Understanding their properties and reactions is fundamental in chemistry, biology, and environmental sciences.

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