



FACULTY OF ENGINEERING SCIENCES

Unit-1

Topic -2nd

Production of Butyric Acid

Mrs. Vandana Yadav

Introduction

- Acetone-butanol-ethanol (ABE) fermentation by *Clostridium acetobutylicum* is one of the oldest known industrial fermentations.
- Butyric acid is a short-chain fatty acid (C_3H_7COOH) In nature, the ester forms of butyric acid exist in animal fat and some plant oils.
(Liu *et al.* 2013)
- Butyric acid has many important applications in chemical, food, and pharmaceutical industries.
- Butyric acid naturally occurs in butter, hard cheeses, milk (especially goat's and sheep's), cream, and in other fermented foods e.g. sauerkraut, pickled cucumbers, and fermented soy products.
- Butyric acid is used to supply butter-like notes in food flavors (off-flavors in beer and chocolate), and its esters are widely used as additives to increase fruit fragrance in the food industry.
- Its includes therapeutic effect for hemoglobinopathies, cancer, and gastrointestinal diseases.
- Butyric acid derivatives have also been developed to produce antithyroid and vasoconstrictor drugs and used in anesthetics.
(Z. Xu. Et., al 2011)

For the production of butyric acid different concentrations of xylose and glucose are involved by *Clostridium tyrobutyricum*.

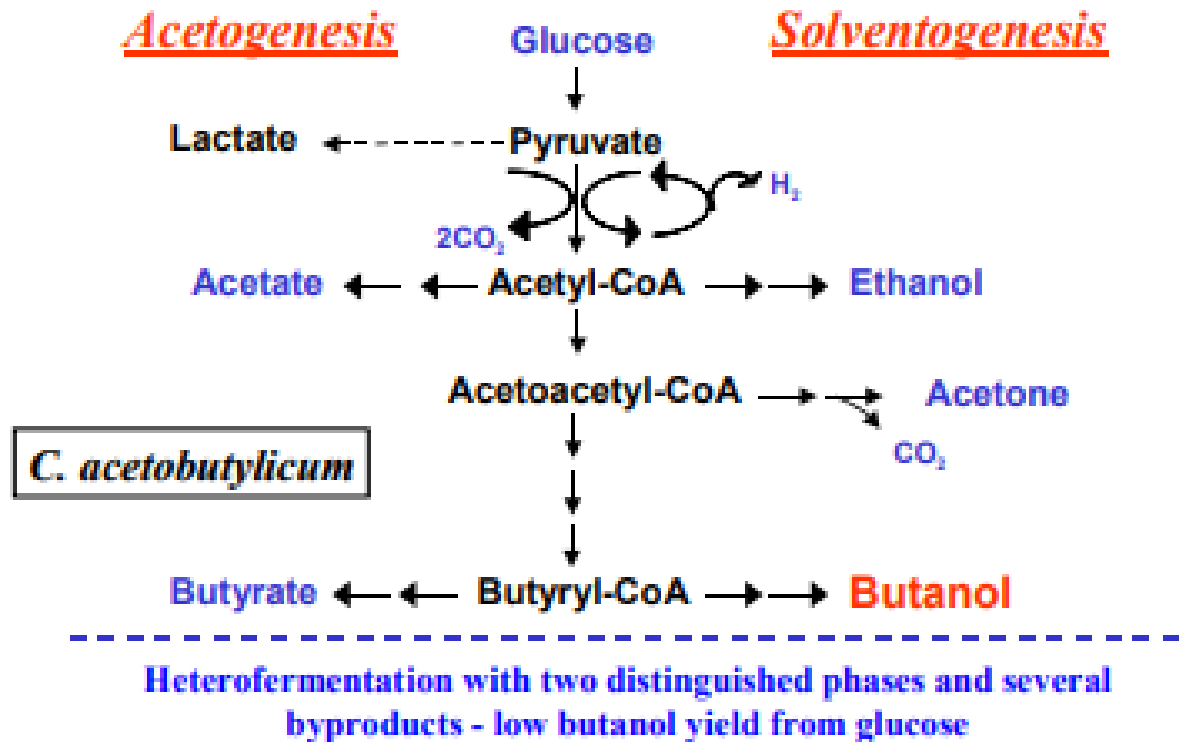


(Luo, G. 2017)

- Butyric acid fermentation is carried out by several obligate anaerobic bacteria that mainly belong to the genus *Clostridium*.
- propionic acid occurs during the degradation of carbohydrates. Another product of the fermentation of proteins and fats is butyric acid.
- This acid also can be generated during the fermentation of carbohydrates from pyruvate. During glycolysis, these are able to oxidize sugar, and irregularly amylose and pectin, to pyruvate.
- The transformation of butyrylCoA into butyrate leads to further ATP production.
- Butyric acid is an important chemical currently produced from petrochemical feedstocks, its also called Butanoic acid, molar mass; 88.11g/mol.
- butyric fermentation done by some bacteria, such as *Clostridium acetobutylicum*, produce less acids and more neutral products, thus carrying out acetone butanol fermentation.

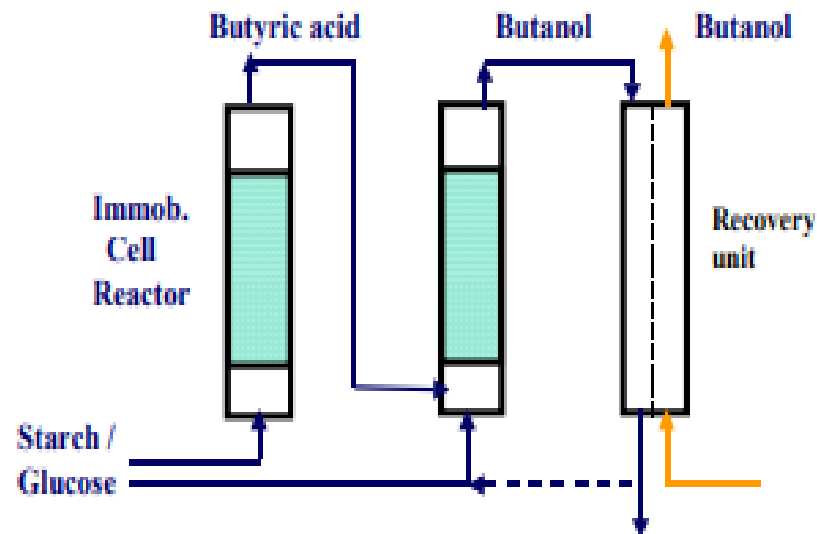
(M. Ciani. et., al 2013)

ABE Fermentation Pathway



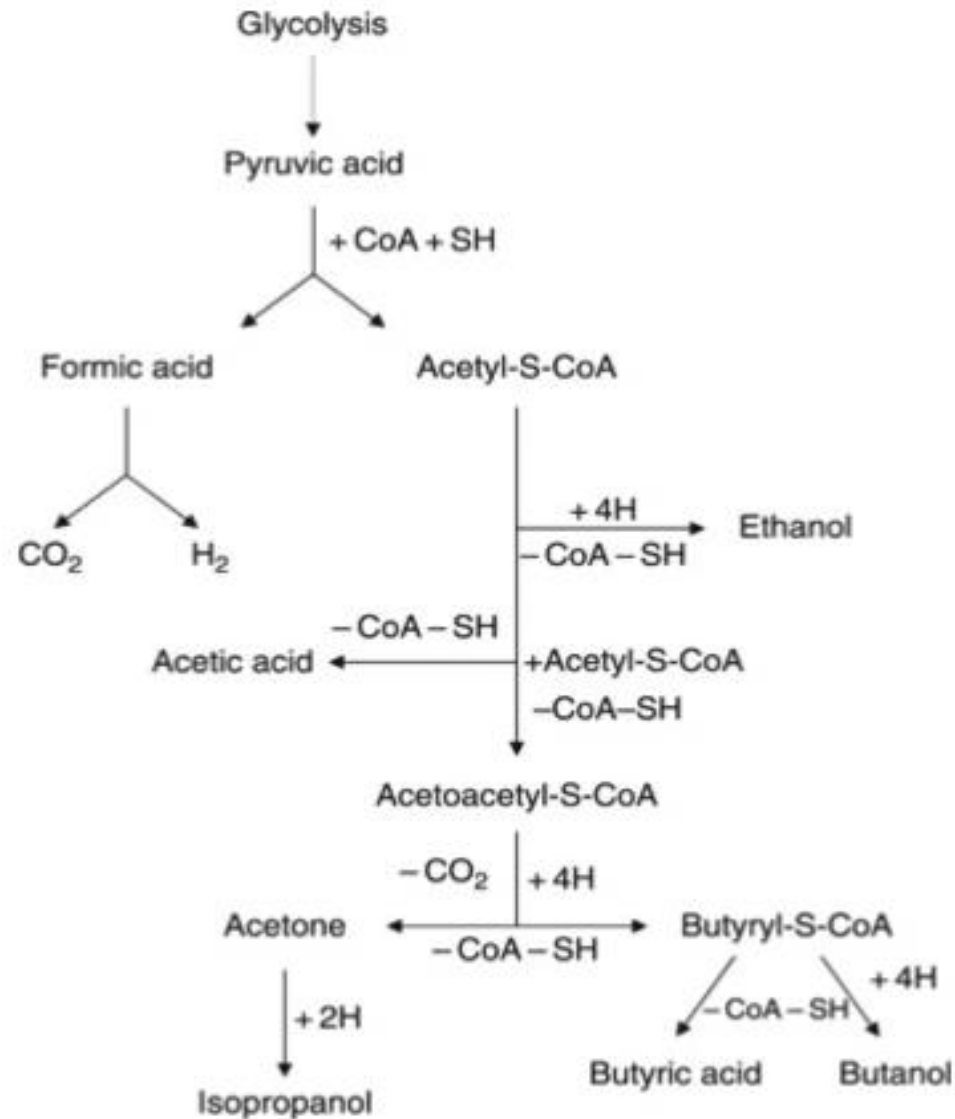
ABE fermentation pathways of *C. acetobutylicum*.

Butanol Production from Starch/Glucose Using a Two-Step Fermentation Process



- . A two-step fermentation process to convert glucose to butyrate and then to butanol.

Metabolic pathways of butyric acid fermentation

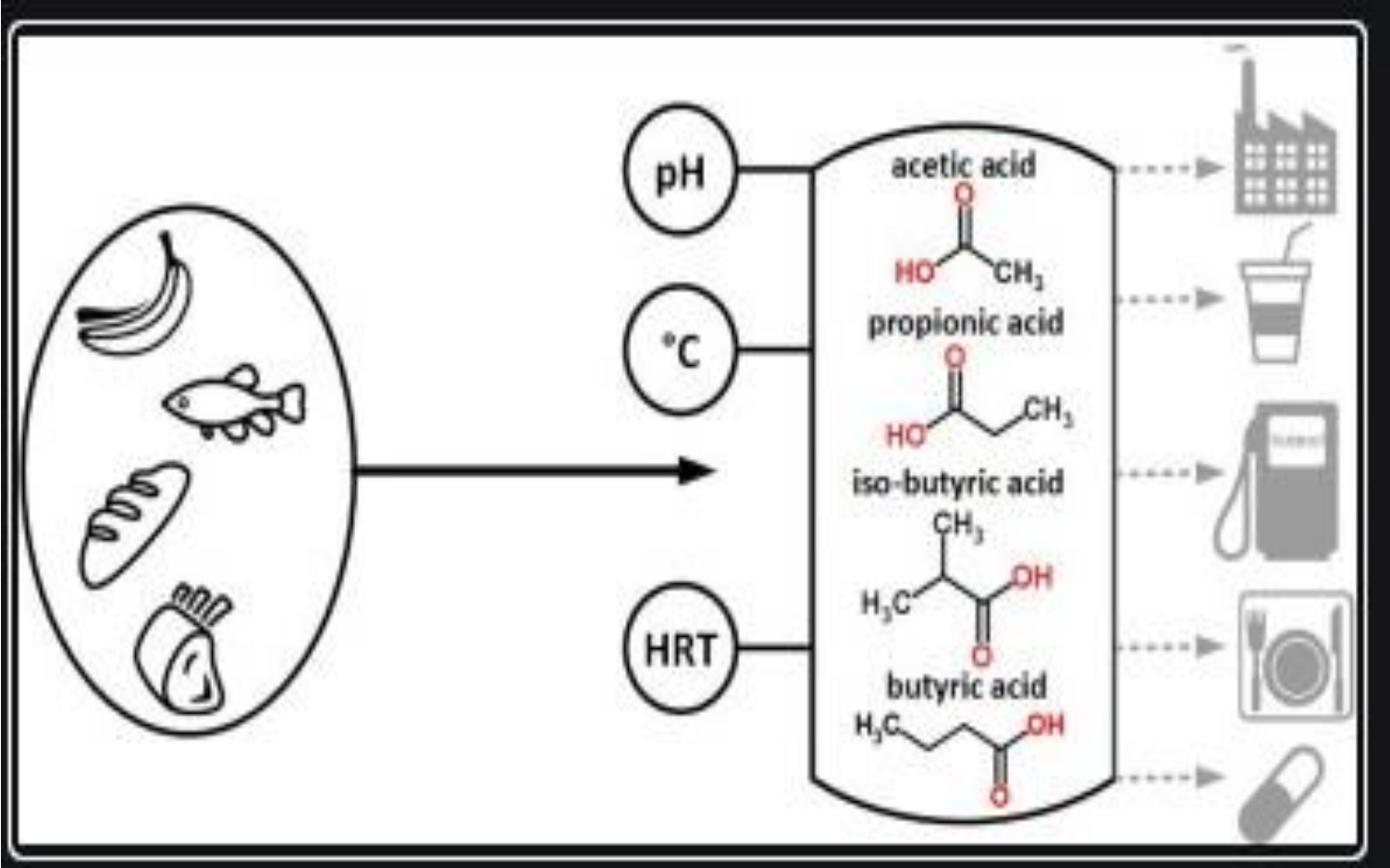


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- ✓ Bioconversion of syngas to organic acids (e.g., acetic and butyric acids) and alcohols (e.g., ethanol and butanol) are the monitors of acetyl-CoA pathway.
- ✓ The most common acidogenic microorganisms include *Clostridium thermoaceticum*, *C. ljungdahlii*, *Peptostreptococcus productus*, *A. woodii*, *Eubacterium limosum*, and *B. methylotrophicum*.
(Henstra et al., 2007)
- ✓ Butyrate is synthesized by the chemical intermediate acetyl-CoA reacting with butyryl-CoA. Acetic and butyric acid yields are highly dependent on the types of microbe and the substrate.
- ✓ The production of butyrate was increased by 10-folds at the expense of acetate yield when the pH shift was from 6.8 to 6.0. Recovery of organic acids produced during syngas fermentation may provide opportunity for additional revenue generation from coproduct.

(Brown, 2006)

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APPLICATION OF BUTYRIC ACID

- ✓ Butyric acid is a valuable building-block for the production of chemicals and materials.
- ✓ Butyric acid has industrial applications in the chemicals, plastics, textiles, food, and pharmaceutical sectors.
- ✓ Demand for biologically and sustainably produced butyric acid is used in food, pharmaceutical, and cosmetic products
- ✓ Butyric acid has many uses in different industries, and currently there is a great interest in using it as a precursor to biofuels;
 - Bioalcohols
 - Vegetable oils and biodiesels
 - Biocrude and synthetic oils
- ✓ It can serve as an intermediate to produce potential biofuels, such as butanol, ethyl butyrate, and butyl butyrate.
- ✓ Major application of butyric acid in the chemical industry is plastics production, especially cellulose acetate butyrate plastics.
- ✓ In addition, plasticizers, surfactants, and textile auxiliaries also use butyric acid as an important ingredient.

(Wu *et al.* 2010)

(Liu *et al.* 2013)

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- Butyric acid is biologically produced by Clostridium species and like other acids (acetic acid, lactic acid, propionic acid), it is toxic to the bacteria after a certain concentration.
 - In order to reduce these costs, in situ removal of butyric acid can be developed. In situ removal strategies are not yet industrially applied for butyric acid, but it is a key area where progress has to be made to make the process economically sustainable.

THANK YOU