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Role Of Factors In The Production Of Bioethanol In Sugar Industry

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Abstract:

Petroleum products contributes major energy source but, it causes environmental pollution and also its cost increases day by day because exhaustible or non-renewable sources. Hence, alternative renewable sources for energy production must increases, which causes less or nil pollution to the environment. Biofuel ethanol reduces the demands of petroleum products. Biofuel ethanol produced by fermentation process with the help of micro-organisms. most common are Sacchromyces cerevisiae.

First generation feedstocks like molasses, sugarcane, grains, sugarbeet etc. second generation feedstocks like lignin, hemicellulose, lignocellulose etc., and third generation feedstocks like algal biomass have been investigated. Production of bioethanol influenced by various factors including concentration of sugars, pH, temperature, rate of agitation, strength of Sacchromyces species etc. This review investigate production of bioethanol in sugar industry which depends upon range of feed stocks. Various factors, industrial procedures, advanced steps in fermentation process etc. The main objective here is to study various process, improvement in the ethanol production fermentation by advanced species of sacchromyces cerevisiae to the going situation.

Keywords : Bioethanol, Biofuel, Temperarture, pH, Concentration of sugar, Agitation rate, Yeast Zymase, Fermentation etc.

Introduction :

Micro-organism like Sacchromyces cerevisiae, unicellular fungus convert glucose into ethanol by the fermentation process, this ethanol is called bioethanol. Fossil fuels increases the atmospheric pollution after oxidation or combustion, which increases CO_2 concentration causes global warming, hence alternative source of energy must be used.

Fermentation process involves conversion of sugar into ethanol and Carbondioxide with the help of yeast or zymase enzyme.

Production of biofuel ethanol increases in few years, and factors like concentration of sugar, temperature, pH, agitation rate etc. are very important to be studied. Which play important role in the productivity. Batch fermentation, fed-batch fermentation and continuous fermentation are the types of fermentation. Important features of biofuel ethanol, possess high octane number value, better flammability, higher flame speed, less polluted, better portability etc,. than that of fossil fuels. The blended bioethanol contains different ratio of bioethanol and gasoline or petrol. In India 10-20% bioethanol blended with petrol.

Molasses, Sugarcane, Sugarbeet, Starch, Sucrose, Glucose, Sorgham, Grains etc. are the important feed stocks to produce bioethanol in Sugar Industry.

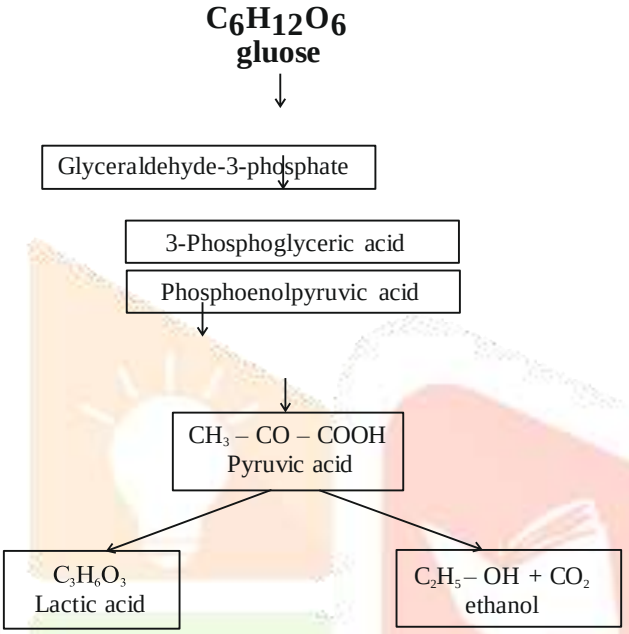


Fig.-1 : Fermentation Process

Main feedstocks for the production of bioethanol :

1. First Generation Feedstocks :
   (a) Sugar crops, eg. – Sugarcane, Sugarbeet, Sweet Sorghum, Grapes etc.
   (b) Cereal crops, eg. – Rice, Barley, Maize, Wheat etc.
2. Second Generation Feedstocks :
   eg. – Lignin, Hemicellulose, Lignocellulose etc.
3. Third Generation Feedstocks : eg. – Algal biomass.

Methodology and Discussion :

Production of bioethanol in industry is divided into three generation feedstocks. Different processes involves in all biofuel generations are,

1. Pretreatment in lignocellulosic feedstock and algalbiomass,
2. Hydrolysis, not required in sugarcane fermentation and
3. Conversion of sugars into ethanol through fermentation process.

Fourth-generation biofuel ethanol produces with the help of genetic engineerin organisms, which enhanced production of biofuel ethanol in fermentation process.

Bioethanol yields from different feedstocks, Sugarbeet 110 L/t, Sugarcane 70-75 L/t, Maize 400 L/t, Rice 430 L/t, Wheat 340 L/t, Sorghum 268-380 L/t, Corn Storer 362-456 L/t, Wheat straw 406 L/t, Rice Straw 416 L/t, Microalge 167-500 L/t, Seagrass (Macroalgae) 747 L/t etc.

Straw, Stalks, Leaves, Husks, Seeds, Bagasse are the important agricultural residues. Fermentation process is an anaerobic process, Sacchromyces Cerevisae contains zymes enzyme which converts sugars into ethanol in acidic medium.

$$C_6H_{12}O_6 \xrightarrow[\Delta]{Feast} 2CH_3 - CH_2 - OH + 2CO_2 \uparrow$$

glucose ethanol

Several micro-organisms are involved in fermentation process but Sacchromyces Cerevisae is the most common due to versatility and greater efficiency.

Optimum pH range and optimum temperature range is suitable condition for efficiency of yeast.

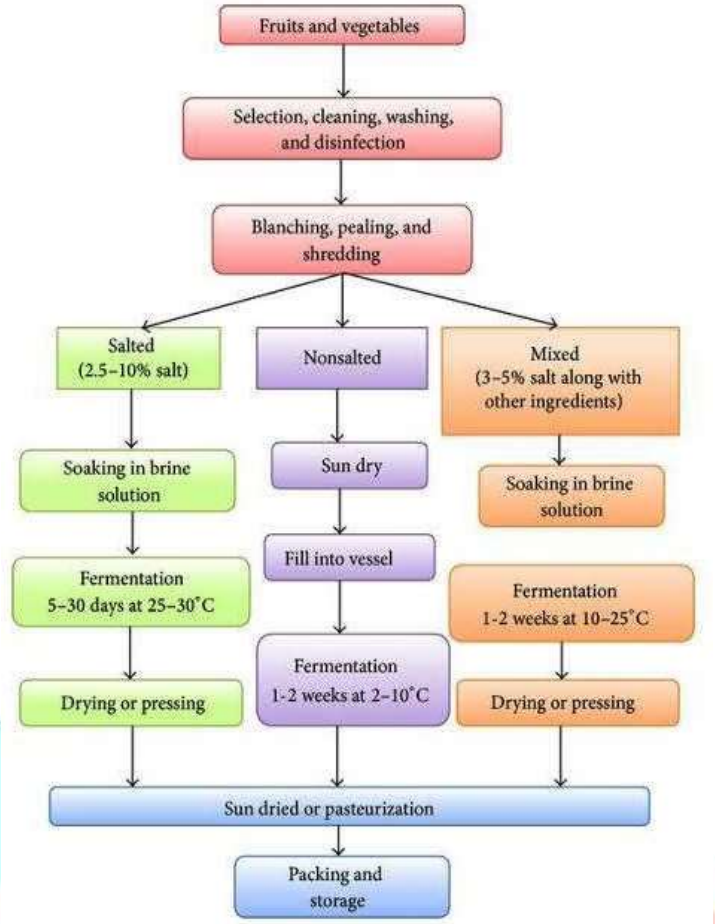
Carbon source, nitrogen source, solid substrate, minerals, vitamins, nutrients and yeast are the important culture media in the fermentation process.

Types of Fermentation :

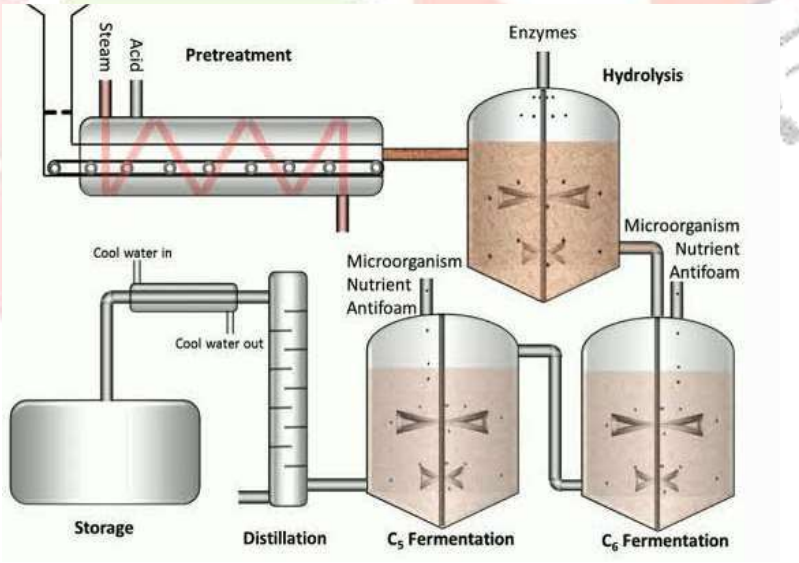
1. **Batch Fermentation :** In this fixed volume of culture medium are provided for micro- organism and culture environment is consistently changing. Its main advantages is low cost, less control required, low risk of contamination and easier sterilization, whereas its main disadvantages is lower cell densities and longer downtime.
2. **Fed-Batch Fermentation :** In this media is inoculated with mirco-organism which then grow at certain period of time, them nutrients are added. Its main advantages are extended life span of cells, higher ehtanol accumulation and control of factors whereas, its main disadvantages are increased costs and longer downtime between batches due to cleaning, vessel set up and sterilization.
3. **Continuous Fermentation :** In this, fresh media is continuously added, replacing the consumed nutrients and toxic metabolites are removed. Its main advantages are low down time for vessel cleaning lower cost, increased productivity and higher degree of control, whereas its main disadvantages are less control for non-growth related products, long growth periods and cell aggregation can prevent optimum steady-state growth. Biofuel ethanol productions affected by following factors.

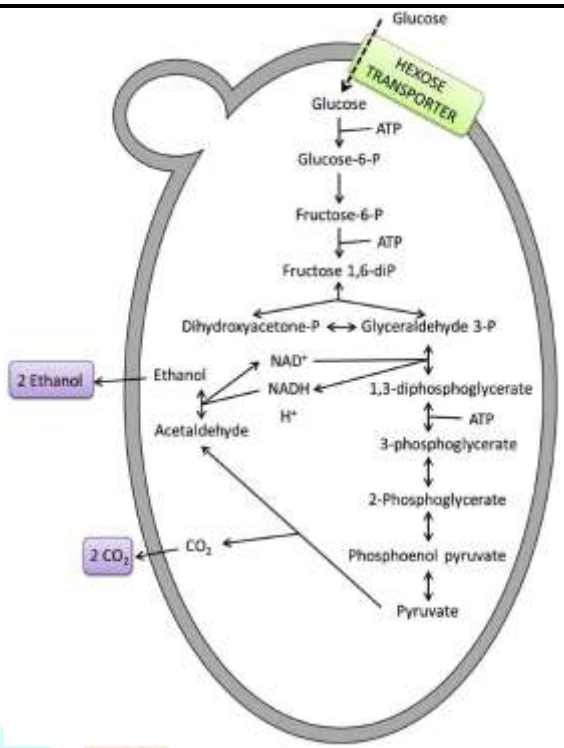
Factors like concentration of sugar, pH, temperature agitation rare etc. are enhances the fermentation process, and the production of bioethanol.

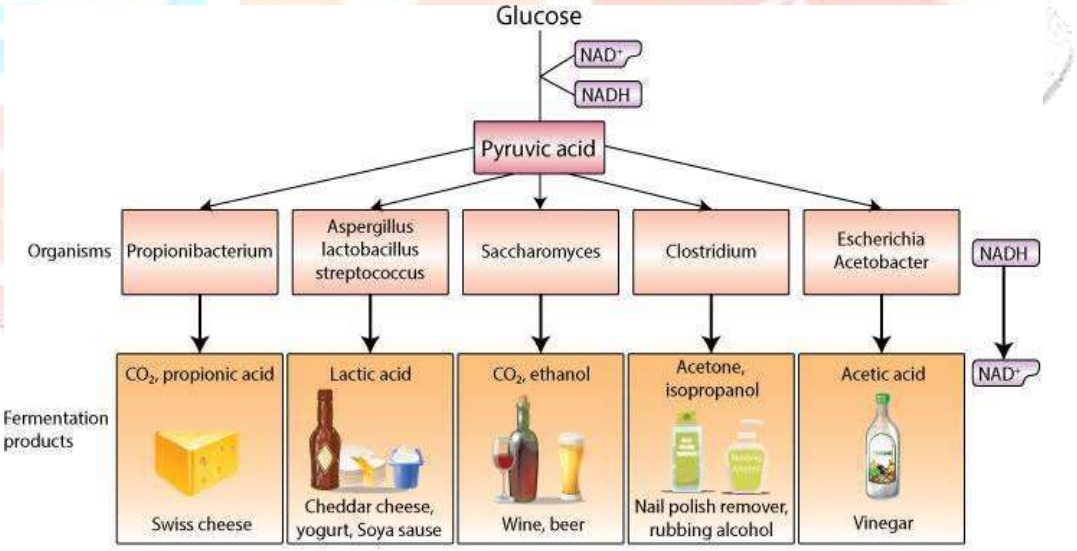
1. **Concentration of Sugar :** Micro-organism cells effected by the initial concentration of sugar, fermentation and the rate of fermentation directly related with the sugar concentrations. If initial concentration of sugar increases then the rate of fermentation increases, due to this production of bioethanol increases. The fermentation process is generally first-order kinetics and the rate of reaction is highly dependent on the substrate concentration.
2. **Temperature :** It is very important factor to control the fermentation process, its optimum range is 20-35℃ bioethanol production depends on the fermentation temperature, if temperature increases slightly then the efficiency of yeast cell decreases and at high temperature yeast cells dies. Enzymatic activity is controls by the temperature and it is very sensitive at the higher temperature. At the optimum temperature range yeast cells grow very well and their activities are better. Sacchromyces Ceravisae shows greater efficiency and growth at 30℃. According to the several researchers if temperature slightly increases then the production of bioethanol increases because rate of the fermentation process increases with the increase in temperature, whereas, at the very high temperature above 40℃, efficiency and growth of the yeast cells decreases.
3. **pH :** In the production of bioethanol by fermentation process pH is the important factor. pH value of the culture media influences the productivity of bioethanol. The optimum pH range for fermentation is between 3.8 to 5.0, whereas, some other micro- organisms also shows better performance at the 5.0 – 6.0, it means production of bioethanol increases in little acidic medium. pH range sugar solution is between 2.5 to 4.5.
4. **Agitation Time :** In the fermentation process agitation rate also the important factor for the production of bioethanol in sugar industry. Agitation rate increases the permeability of nutrients and sugar consumption by the yeast cells and also reduces the inhibition of ethanol on cells. The optimum agitation rate is between 120 – 250 rpm form different micro-organisms for Sacchromyces Cerevisae, it is 150 – 200 rpm. According to Lie and Shen production of bioethanol is maximum at 200 rpm of agitation rate.

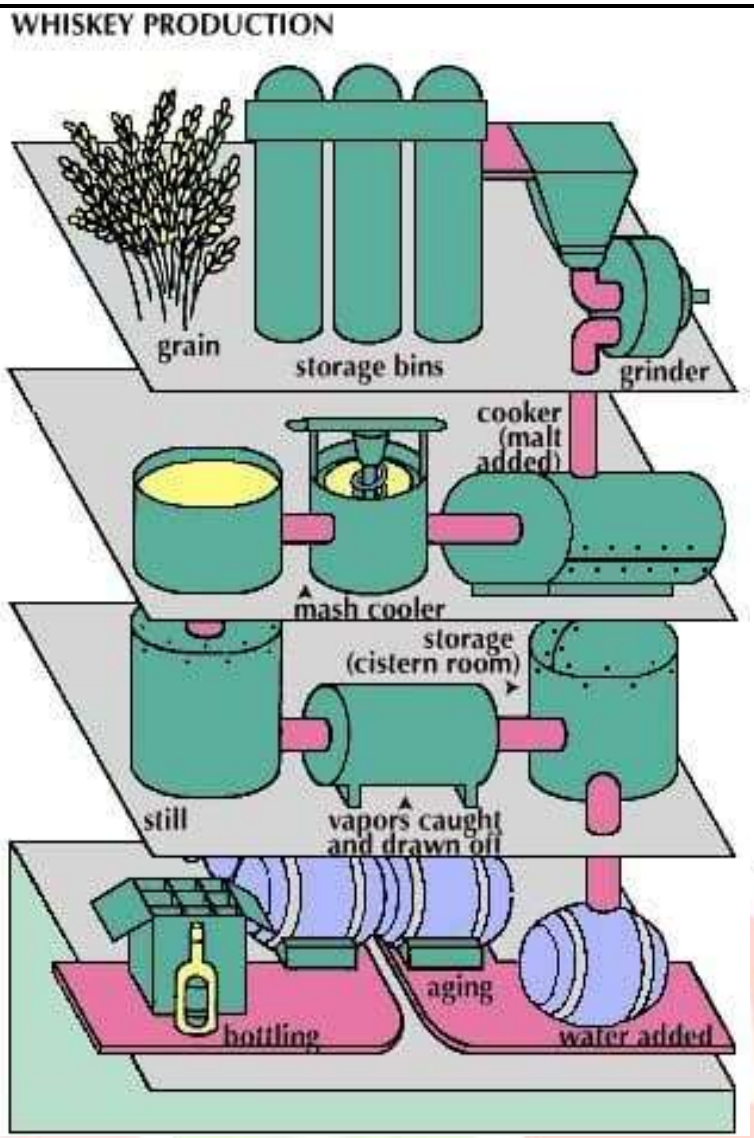


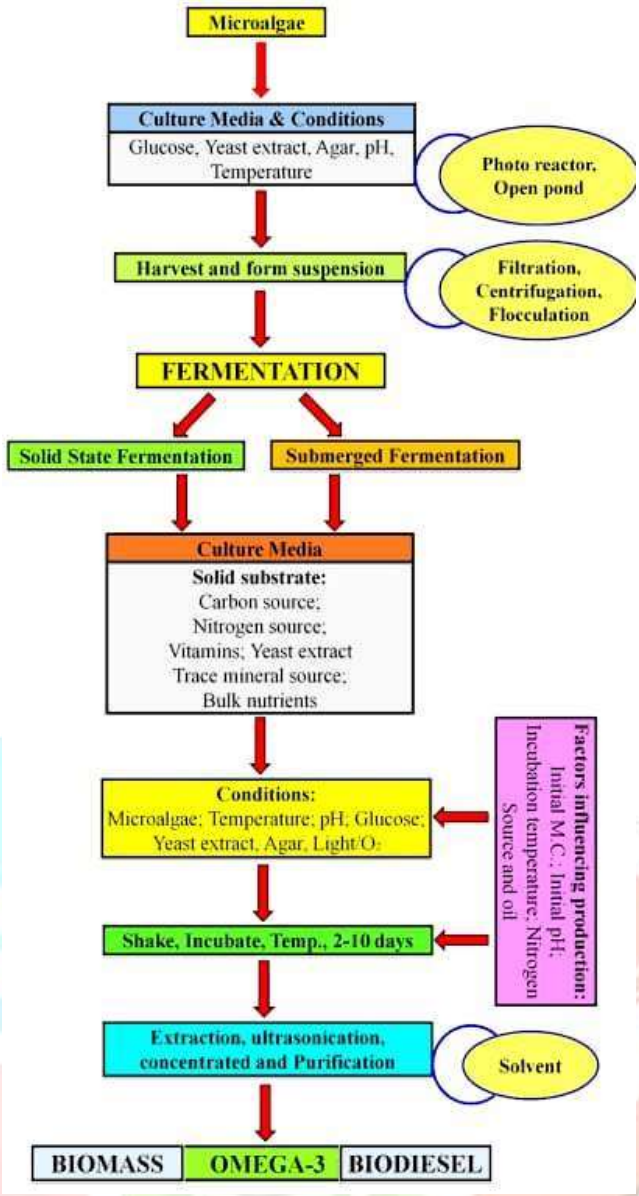
Fermentation




Glucose
HEXOSE TRANSPORTER
Glucose
ATP
Glucose-6-P
Fructose-6-P
ATP
Fructose 1,6-diP
Dihydroxyacetone-P
Glyceraldehyde 3-P
2 Ethanol
Ethanol
NAD+
NADH
H+
1,3-diphosphoglycerate
ATP
Acetaldehyde
3-phosphoglycerate
2-Phosphoglycerate
2 CO2
CO2
Phosphoenol pyruvate
Pyruvate


Glucose
NAD+
NADH
Pyruvic acid
Organisms
Propionibacterium
Aspergillus lactobacillus streptococcus
Saccharomyces
Clostridium
Escherichia Acetobacter
NADH
NAD+
Fermentation products
CO2, propionic acid
Swiss cheese
Lactic acid
Cheddar cheese, yogurt, Soya sause
CO2, ethanol
Wine, beer
Acetone, isopropanol
Nail polish remover, rubbing alcohol
Acetic acid
Vinegar


WHISKEY PRODUCTION
grain
storage bins
grinder
cooker
(malt
added)
mash cooler
storage
(cistern room)
still
vapors caught
and drawn off
aging
bottling
water added



Conclusion :

Energy demand increases day by day, production of biofuel ethanol from non- exhaustible sources is a valuable and also not causes environmental pollution largely, which is alternative to exhaustible petroleum products. Fermentation efficiency and the production of bioethanol depends on feedstock,

culture media, yeast, nutrients, minerals, vitamins etc, Batch, Fed-Batch and continuous fermentation is the types of fermentation. Starch and free fermenatable sugars mainly employed in fermentation process. Various factors like concentration of sugar, pH, temperature, agitation rate etc. enhances the production of bioethanol in sugar industry. Second and third generation feedstocks required pre-treatment conditions. The main objective here is to study improvement in fermentation various process involved in fermentation, factors controlling etc. to the on going energy demand situation.

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