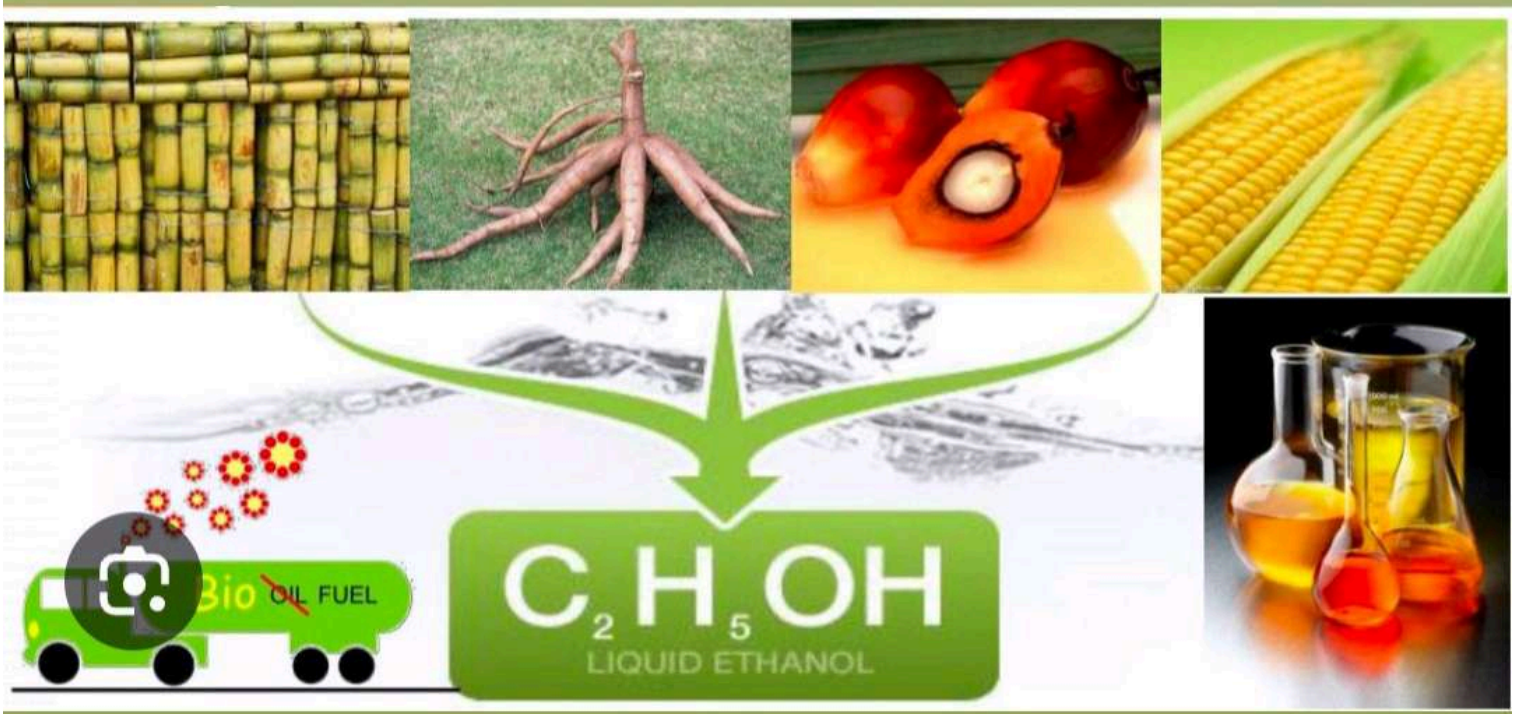
Application of fungi in fermentation

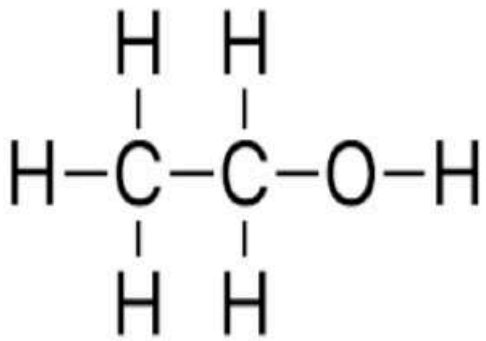
PRODUCTION OF ETHYL ALCOHOL (ETHANOL)

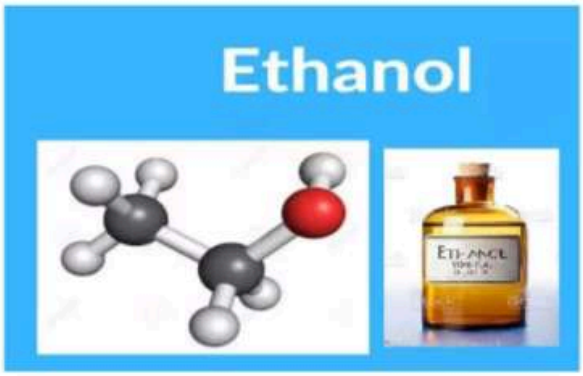


***Production of Ethanol from different* Sources**

Introduction: -

A Quick review to the Ethanol, Ethanol is a volatile, flammable, colorless liquid with a slight chemical odor. It is the Principal type of alcohol found in alcoholic beverages, produced by the fermentation of sugars by yeasts. It is a neurotoxic, psychoactive drug and one of the oldest recreational drugs. It can cause alcohol intoxication when consumed in sufficient quantity. It is also known as grain alcohol, ethyl alcohol, and drinking alcohol. It's the intoxicating agent in fermented and distilled liquors; used pure or denatured as a solvent. Empirical Formula of Ethanol is C2H5OH.





History: -

The fermentation of sugar into ethanol is one of the earliest organic reactions that man learned to carry out and the history of man-made ethanol is very long. Dried ethanol residue have been found on 9000 year old pottery in China which indicates that Neolithic people in this part of the world may have consumed alcoholic beverages. Distillation was well known by the early Greeks and Arabs. Greek alchemists working in Alexandria during the first century A.D carried out distillation. Fractional distillation was invented by Tadeo Alderotti in the 13th century. The year 1796 is significant for ethanol history because this is when Johann Tobias Lowitz obtained pure ethanol by filtering distilled ethanol through activated charcoal. In mid 1800s, ethanol became one of the first structural formulas to be determined The scientist behind the description was Scottish chemist Archibald Scott.

Raw Material for the production of Ethanol: -

1. Saccharine containning products (such as Grapes, Banana, Apples, Pineapples, Pears, Peaches, Oranges, Watermelon, Molasses, Cane Sorgum, Sugarcane, Sugar beet, Sugar Corn waste, etc)

2. Starchy Material (Such as Grains, Potatoes, Artichokes, Sweet Potatoes, etc)

3. Cellulose Material

grains

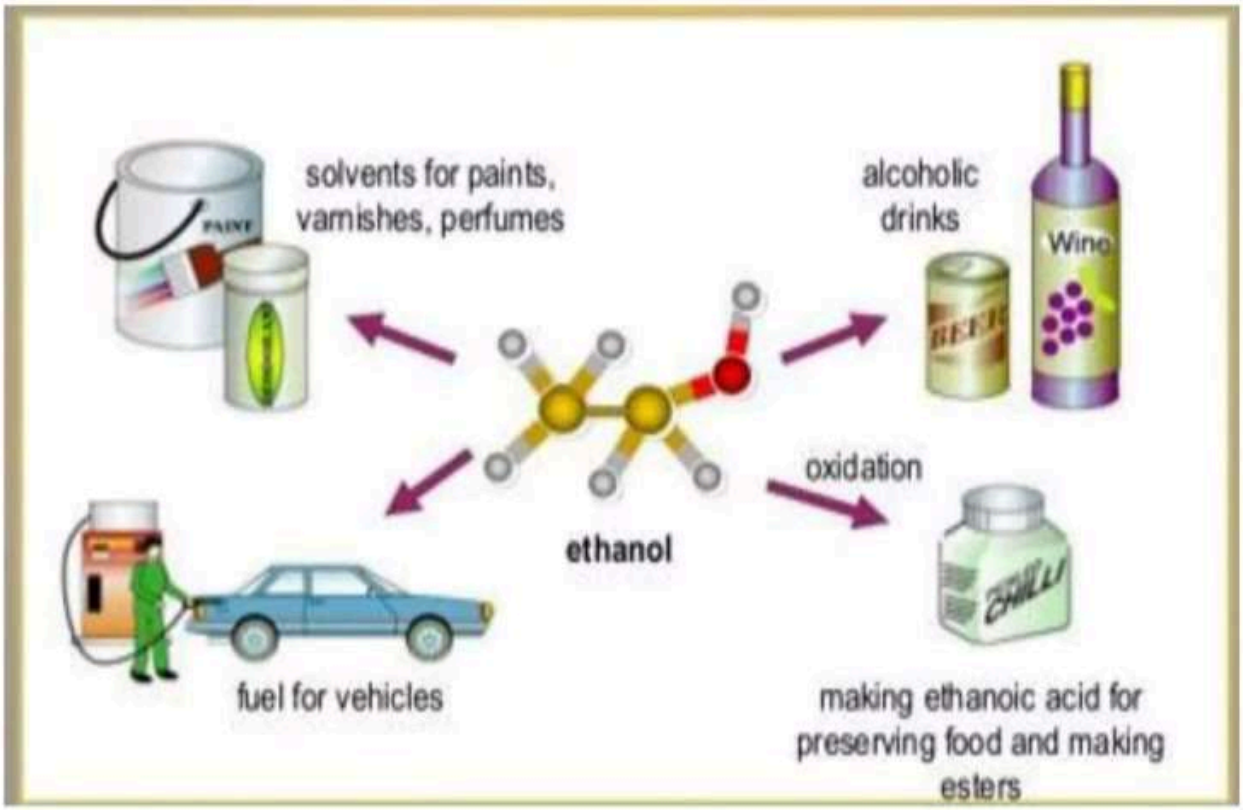
artichokes

potatoes

sweet potato

Uses of Ethanol: -

It is used as Alcoholic drinks, For making ethanoic acid for preserving food and making esters, Fuels for vehicles, Used as solvents for paints, varnishes, perfumes.



Microorganisms invoved in the Production of Ethanol: -

1. *Fungi*

a) *Saccharomyces cerevisiae*
b) *Schizosaccharomyces*

2. *Bacteria*
   a) *Zymomonas mobilis*
   b) *Clostridium acetobutylicum*
   c) *Klebseilla pnemonia*
   d) *Candida brassica*

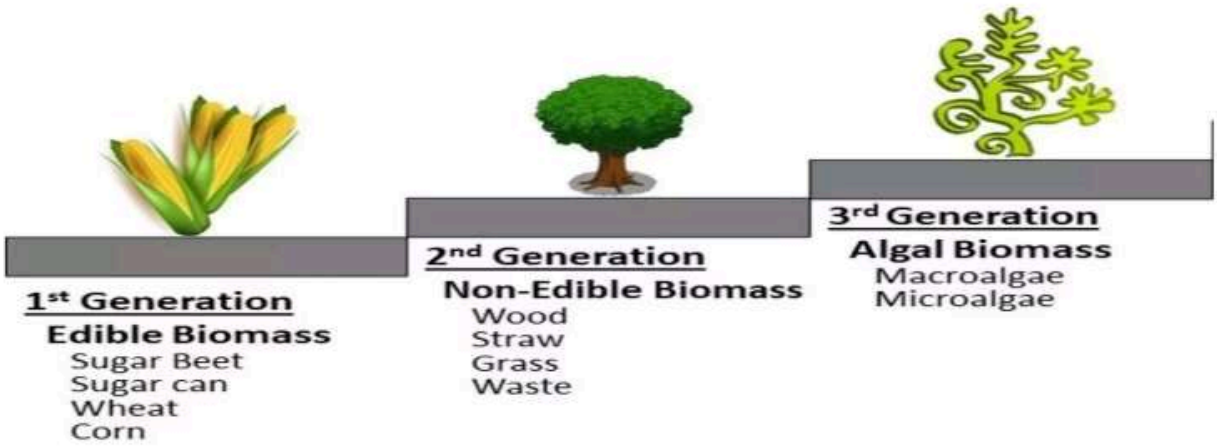
Crops used in various countries for Production of Ethanol: -

In INDIA & BRAZIL crop used for production of ethanol is Sugarcane. While, In USA crop used for production of ethanol is Corn. While, In EUROPE crop used for production of ethanol is Wheat,& Barley.

Production of Ethanol: -

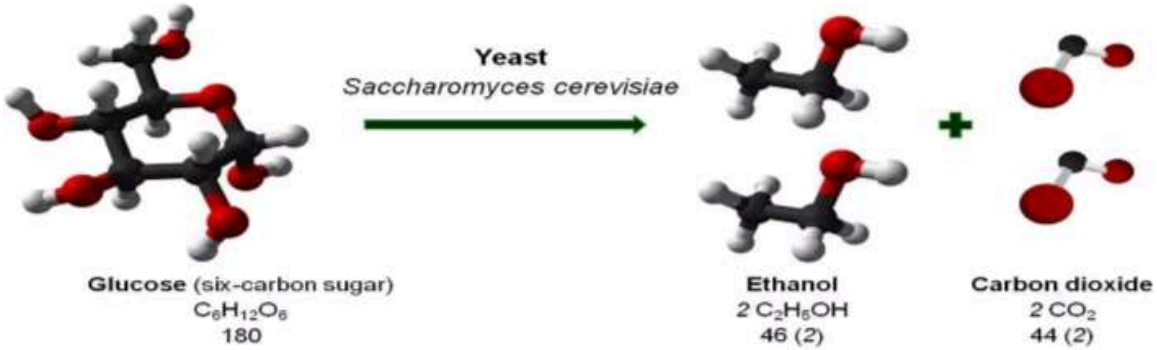
Ethanol is produced from different ways-

1. First Generation Ethanol, were we use Sugar which is converted to Ethanol Where we also see Starch getting converted to Sugar to Ethanol.
2. Second Generation Ethanol, were we use Cellulose or Hemi cellulose which is converted to Ethanol.
3. Third Generation Ethanol, were we see Algal biomass converting Sugar to Ethanol.



Fementation: -

Fermentation is the oldest way for humans to produce ethanol, and this is the traditional way of making alcoholic beverages. It is also the process used for the vast majority of ethanol fuels on the market. When certain species of yeast metabolize sugar, the end result is ethanol and carbon dioxide. One example of such a species is Saccharomyces cerevisiae, which has been used by brewers since ancient times. In Greek Saccharo means sugar and myces means fungus. This is the chemical formula for turning sugar into ethanol and carbon dioxide.



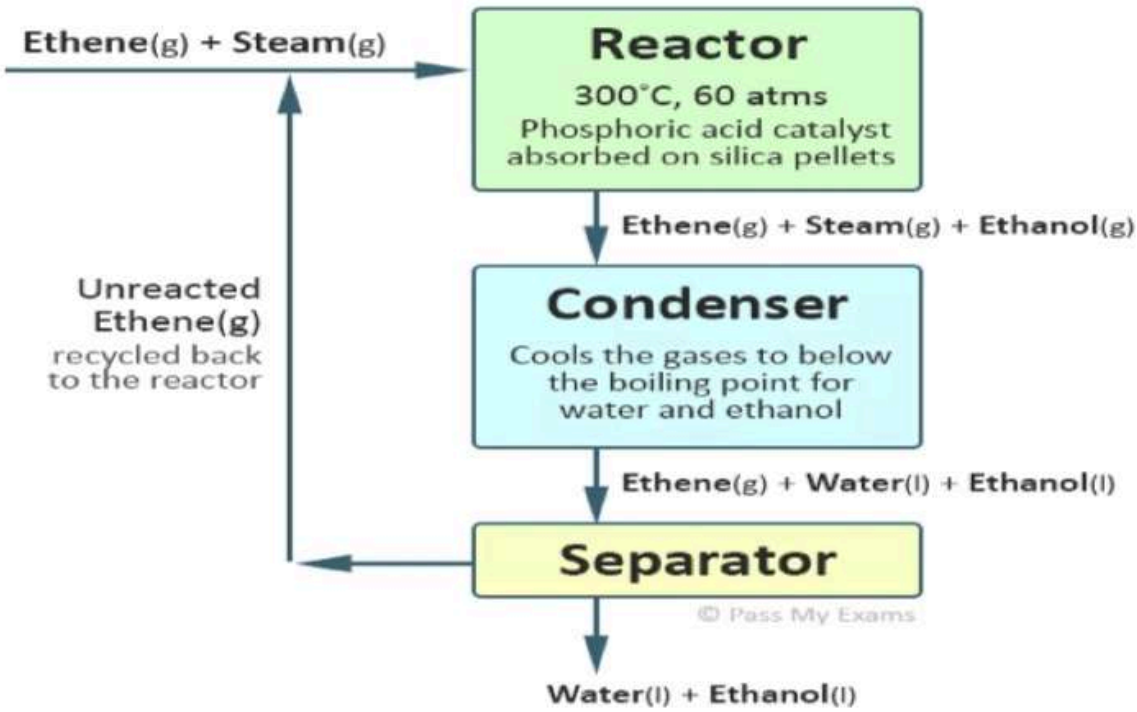
In the 1st Generation of Ethanol; where Sugarcane is extracted to sugars which is fermented to ethanol. While, In the 2nd Generation of ethanol; The Cellulosic biomass is pre-processesed in which the size is reduced and further pretreated slurry is consolidated for Bioprocessing which included Hydrolysis & Fermentation. After Bioprocessing, the product is distilled & dehydrated which leads to the production of Ethanol, which is an exothermic process. In the 3rd generation production of ethanol, within which Algal biomass is cultured in an Open or a close reactor on addition of water and nutrients to the reactor it is harvested which includes various process such as Centrifugaation, Floatation, Sedimentation, Filtration, Floculation; from which Oil is extracted along with residues or Biomass. This Algal Oil is sent for Transesterification, while the remaining Biomass is sent for the Fermentation process (where the first Generation process is carried out for production of ethanol). The Alcohol produced from the catalysis of the algal oil is decanted or separated to Glycerol and the formation of Biodiesel.

Difference in various generation of production of ethanol: -

1st Generation is derived from edible plants, Ethanol & Butanol produced via yeast fermentation. Raw material includes wheat, Sugarcane, & oily seeds. Net energy is negative. 2nd Generation is derived from Non-Edible Crops, Sources have high ligno-cellulosic content. Raw material includes Wood and organic waste.Net energy is Positive. 3rd Generation is derived from algal biomass and other microorganisms. The resilient organisms that can be grown from sunlight, Co2 and brackish water. It is the fastest growing of all ethanol sources.

Ethene Hydration: -

The another method of production of ethanol through Ethene Hydration, the process is carried out in such a way when ethene comes in contact with steam at a temperature of 300 degree Celcius at a pressure of 60 atmosphere. Ethanol is produced which is in a gaseous state; which is condensed further by cooling the gas below the boiling point, leading to formation of Ethanol. The unreacted ethene is further recycled back for the production of ethanol.

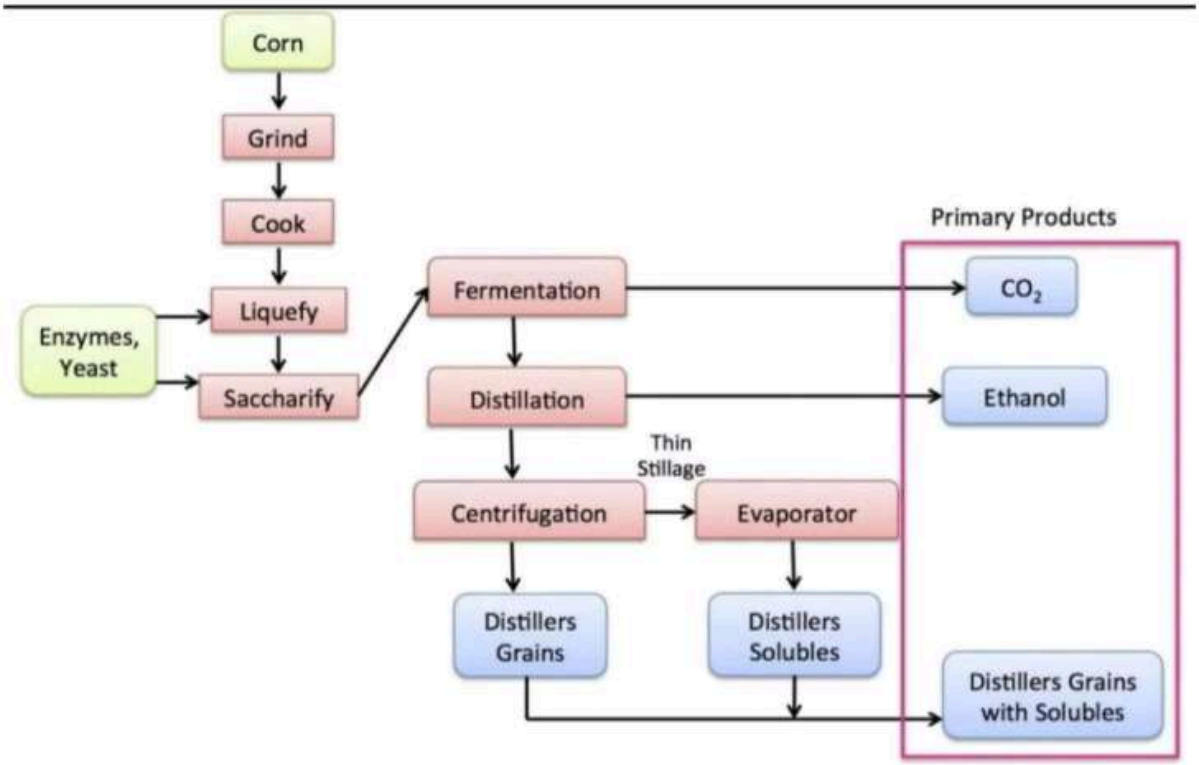


Industrial Production of Ethanol by Wet Milling: -

1. Milling: involves processing the corn through a hammer mill .This whole corn flour is slurred with water, and heat-stable enzyme (a amylase) is added. Further
2. Liquefaction is accomplished using jet-cookers that inject steam into the corn flour slurry to cook it at temperatures above 100°C (212°F).The heat and mechanical shear of the cooking process break apart the starch, and the enzymes break down the starch polymer into small fragments.The cooked corn mash is then allowed to cool to 80-90°°C (175 195°F), additional enzyme (a-amylase) is added, and the slurry is allowed to continue liquefying for at least 30 minutes. Then in

3. Saccharification - The slurry is cooled to approximately 30°C (86°F), and a second enzyme glucoamylase is added. Glucoamylase completes the breakdown of the starch into simple sugar. Further
4. Fermentation is carried in the Yeast grown seed tanks are added to the corn mash to begin the process of converting the simple sugars to ethanol. And finally,

5. Distillation followed by Recovery is done After fermentation, the liquid portion of the slurry has 8-12% ethanol by weight. Conventional distillation/rectification systems can produce ethanol at 92-95% purity. • The residual water and corn solids that remain after the distillation called as "stillage." is then centrifuged to separate the liquid (thin stillage) from the solid fragments (wet cake or distillers' grains).The thin stillage is passed through evaporators to remove a significant portion of the water to produce thickened syrup. Usually, the syrup is blended with the solid fragments and dried to produce an animal feed called "distillers' dried grains with solubles" (DDGS).



Advantages of Ethanol: -

1. Exhaust gases of ethanol are much cleaner.
2. Ethanol-blended fuels such as E85 (85% ethanol and 15% gasoline) reduce up to 37.1% of Green House Gases.
3. Output of energy during the production is more than the input
4. The CO2 released in the bioethanol production process is the same amount as one of the crops previously absorbed during photosynthesis.

Disadvantages of Ethanol: -

1. It is not as efficient as petroleum- Energy content of the petrol is much higher than bioethanol. Its energy content is 70% of that of petrol.
2. Engines made for working on Bioethanol cannot be used for petrol or diesel- Due to high octane number of bioethanol, they can be burned in the engines with much higher compression ratio.
3. They have cold start difficulties aspure ethanol is difficult to vaporise.