BrewTimes™

AUGUST 2023

BALAJI ENZYME & CHEMICAL PVT LTD

Akshay Mittal Industrial Estate
A-113, 1st Floor, Building No 5, Sir M V Road, Andheri (East),
Mumbai - 400059 | +91-22-460 31 666
E-mail : info@becpl.in | Web. : www.becpl.in

Introducing BrewTimes :

We M/s Balaji Enzyme & Chemical Pvt Ltd, are pleased to bring to you our August 2023 month edition of BrewTimes.

We would like to use this platform to introduce our association with BetaTec, UK for their natural solutions for ethanol recovery in grain and molasses distilleries. The product is revolutionary and unlike any in the market is 100% natural and antibiotics free. Vitahop series of products helps in ensuring optimum yield and keeps the yeast healthy all naturally.

We are extremely proud of announcing our association with IIT Bombay Research Park. We have begun a journey together to work on sustainable, reliable and innovative solutions for the Food and Beverage Industry.

About Our Company :

We M/s Balaji Enzyme & Chemical Pvt Ltd are a leading supplier of Enzymes, Filter aid, Yeast, Hops, Processing aids, Clarifiers and food fortification products to breweries, distilleries, malt extract industry, starch industry, juice and beverage industry, and other food industry.

HopAid® Antifoam

Purpose

HopAid® Antifoam is used during fermentation to prevent excessive foam formation. It can be used for top and bottom fermented beers in all kinds of fermenters. Produced with deionised water and hop extract is considered food safe in both USA (GRAS) and EU.

Product Specifications

Appearance:	Creamy pale yellow emulsion
Odour:	Slight odour of hops
Solids:	< 12%
Yeast and Moulds*:	< = 10 cfu/g
TVC*:	< = 100 cfu/g
Centrifuge Test:	Pass / Fail

* Values monitored on a regular basis but not on every batch.

Composition

Ingredient	Range
Hop Extract fraction	5 – 10 %
Food grade emulsifier	0.1 – 2 %
Water	Balance

Application

HopAid® Antifoam should be dosed into cold wort. Either inline or, alternatively, dosed into the fermenter before the cold wort is transferred. This will ensure good mixing with the wort which is essential for optimum performance. Dosing into hot wort will lead to unpredictable losses in the hot trub.

Depending on the brewing recipe and fermentation regime the dose rate for most applications will lie between 5 and 50 g/hL. For a normal strength lager type a starting dose rate of 20 g/hL is recommended. However, fermentations with high levels of foam stabilizing substances such as hop acids and proteins, dark malts and higher fermentation temperatures may require higher dosing

rates. Products with high levels of adjuncts may require lower levels of HopAid® Antifoam addition. If the brewer is using a synthetic, silicone based product the dose rate can be used as an indication. In most cases HopAid® Antifoam should be dosed at 2x the concentration as the Silicone based product.

Effect of HopAid® Antifoam on the final beer

Technical studies and feedback from customers have not shown a negative impact on final beer foam, in fact some data suggest a positive one.

HopAid® Antifoam: Yeast and pH

Yeast removes the vast majority of the active components by adsorption on to the cell wall. Any remainder may be removed by filtration.

HopAid® Antifoam is incompatible with strong acids and bases.

Strong acids and strong bases will damage the antifoam, so HopAid® Antifoam should not be added to yeast directly after acid washing of the yeast. Beer pH is fine.

Trial Design:

The trial should consist of 2 initial trial fermentations, both with the same volume of wort and in tanks with the same dimensions. To the first fermentation no HopAid® Antifoam should be added (control sample) and the foam height should be monitored. Ensure that the tank is big enough to include the foam built in the control sample. The second fermentation with HopAid® Antifoam, added in the recommended starting dose rate, should use the same wort volume. To understand the required dose rate and the effects of HopAid® Antifoam, it is important to measure the following attributes if possible:

- Foam height in fermentation tank
- IBUs of the beer
- % of attenuation
- Beer foam stability

Safety

There are no known health hazards for this product. Please consult safety data sheet for full information.

Packaging

HopAid® Antifoam Antifoam is packaged in 1 kg Tetrapacks and 10 kg aluminium foils.

Transport

Transport temperatures should be maintained above 0°C to ensure the product does not freeze

Storage

Ideally store away from direct sunlight and between 5°C and 20°C if unopened. HopAid® Antifoam can be stored in the original unopened containers for up to 15 months. Do not freeze as this will cause the emulsion to collapse. If this occurs the product can be redispersed by shaking to restore its antifoam capacity. Open containers should be stored cool (+5°C) and used within 2 days.

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PHA® Topnotes

PHA® Topnotes in propylene glycol (PG)

General:

PHA® Topnotes are prepared from cone hops by specific extraction and distillation methods. They consist of original hop oil compounds in a propylene glycol (PG) solution. PG is a permitted carrier for flavours as per regulation 2006/52/EC. PHA® products are exclusively supplied worldwide by the Barth-Haas Group.

Figure 1: PHA® Topnotes

Characteristics:

PHA® Topnotes are soluble in beer (or other beverages). In general, PHA® products offer an alternative means of adding hop aroma independent of any other product or process. Specifically, PHA® Topnotes give a very intense 'dry hop' aroma to beer that is characteristic of the specific variety from which it is prepared. They enhance pleasant existing flavors in the beer/soft drink and can mask some off-flavors. The following PHA® Topnotes are immediately available:

PHA® Topnotes:

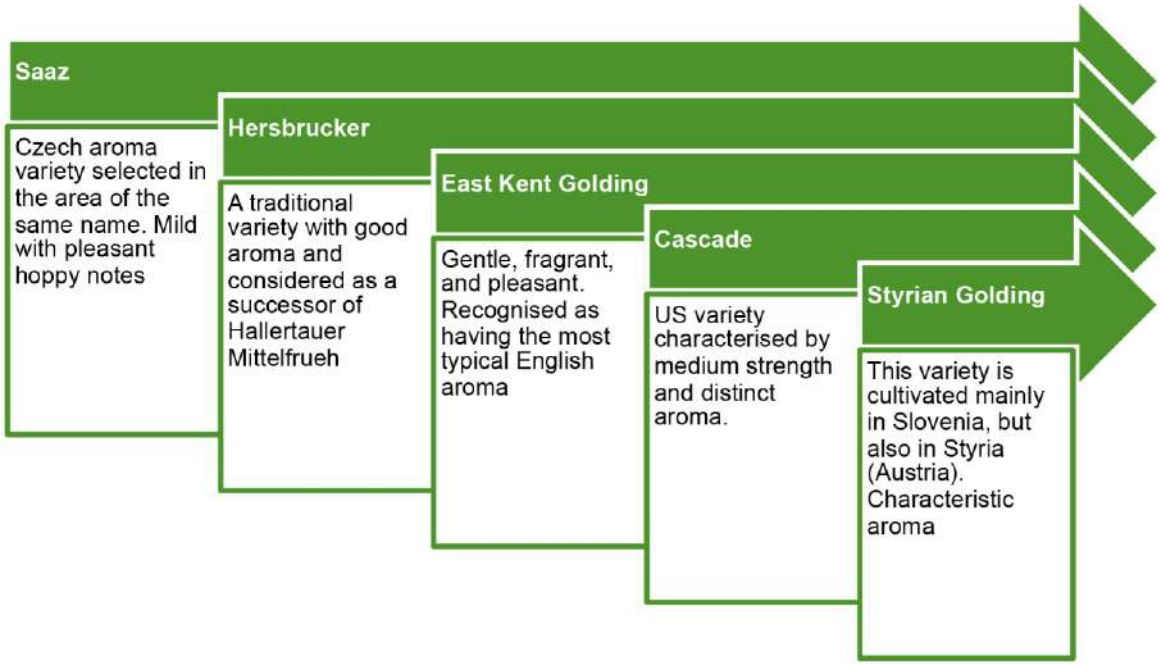

Figure 2: Examples from the PHA® Topnote range

Custom made Products:

Custom-made PHA® Topnotes from other varieties are available on request.

BARTH-HAAS GROUP
FOR YOUR SUCCESS

Product specifications:

Description:	water white solution, can be hazy
Specific Gravity (20oC):	1.034 - 1.037
Flash point:	> 90 °C (194 °F)

Product Use:

PHA® products are completely soluble in beer and are intended for addition to fined or filtered beers. The required amount of PHA® may be metered directly into the beer stream during transfer to bright beer tank or other appropriate vessel. A usage rate of PHA® per hectoliter normally is about 10 ml but might vary between 5 – 40 ml according to the desired intensity of aroma. We recommend laboratory scale trials to determine which concentration gives the desired effect. This evaluation can be carried out on bottles of 250 to 500 ml capacity.

On a large scale, PHA® Topnote products are used as a post fermentation addition to finished beer, where 100% utilization is feasible. PHA® Topnote products are lightstable and therefore can be used to introduce hop aroma into a beer brewed using exclusively downstream products such as Tetrahop Gold® and Redihop®. These products may be added without prior dilution to beer either before or after the final filtration preferably by metered injection into a turbulent beer stream during transfer. They can also be added to bright beer without any increase in haze or deterioration in foam stability. If possible the pump should be adjusted to deliver the PHA® over approx. 95% of the total transfer time.

Trial Guide:

We recommend benchtop trials to determine which concentration gives the desired effect. To get a better initial understanding for the effect of individual PHA® products and the required dose rate, we recommend dosing directly into a glass of beer. For more accurate results, we suggest following this up with dosing into bottles as explained below. The rate for initial tasting trials should be approximately 10 mL/hL of the PHA® as supplied. PHA® products can be dosed directly using a micropipette or syringe. For example, a 330 mL bottle, a 33µL amount of PHA® gives a dose rate equivalent to 10mL/hL. Chill the beer to normal drinking temperature. Open and introduce the required volume of PHA® in the headspace of the beer bottle and reclose the bottle. Invert the bottle several times to ensure mixing and chill again for at least two hours before opening and tasting.

Special properties of PHA®:

The PHA® products have the following properties:

- Natural: 100% derived from hops by physical processes.
- Fully soluble: utilisation is 100% because of full solubility in beverages.
- No negative impact on beer quality: Do not increase beer haze or reduce beer foam stability.
- Easy handling: Provided as standardised solution for direct dosing.
- Light stability: free of hop α-acids; can be used with any packaging type.
- Ideal for brand diversification: differentiate existing products or create new ones.

Packaging:

The standard package size of PHA® is 1 and 5 l aluminium flask. Larger package units are available on request.

Storage and shelf life:

PHA® products are stable in unopened containers for at least 24 months. Store at

0-20 °C (32-68 °F) in high-grade stainless steel, glass, aluminum or lacquered steel drums.

Safety:

Please refer to our SDS which can be downloaded on our website.

Technical Support:

We will be pleased to offer help and advice on the use of PHA® in brewing/soft drink production.

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PHA® Varietals

PHA® Varietals in propylene glycol (PG)

General:

PHA® Varietals are prepared from cone hops by specific extraction and distillation methods. They consist of original hop oil compounds in an aqueous propylene glycol (PG) solution. PG is a permitted carrier for flavours as per regulation 2006/52/EC. PHA® products are exclusively supplied worldwide by the Barth-Haas Group.

Figure 1: PHA® Varietal

Characteristics:

PHA® Varietals are 100% soluble in beer (or other beverages). In general, PHA® products offer an alternative means of adding hop aroma independent of any other product or process. Specifically, PHA® Varietals give a subtle 'late hop' aroma to beer that is characteristic of the specific variety from which it is prepared. They enhance pleasant existing flavors in the beer/soft drink and can mask some off-flavors. The following PHA® Varietals are available:

PHA® Varietals:

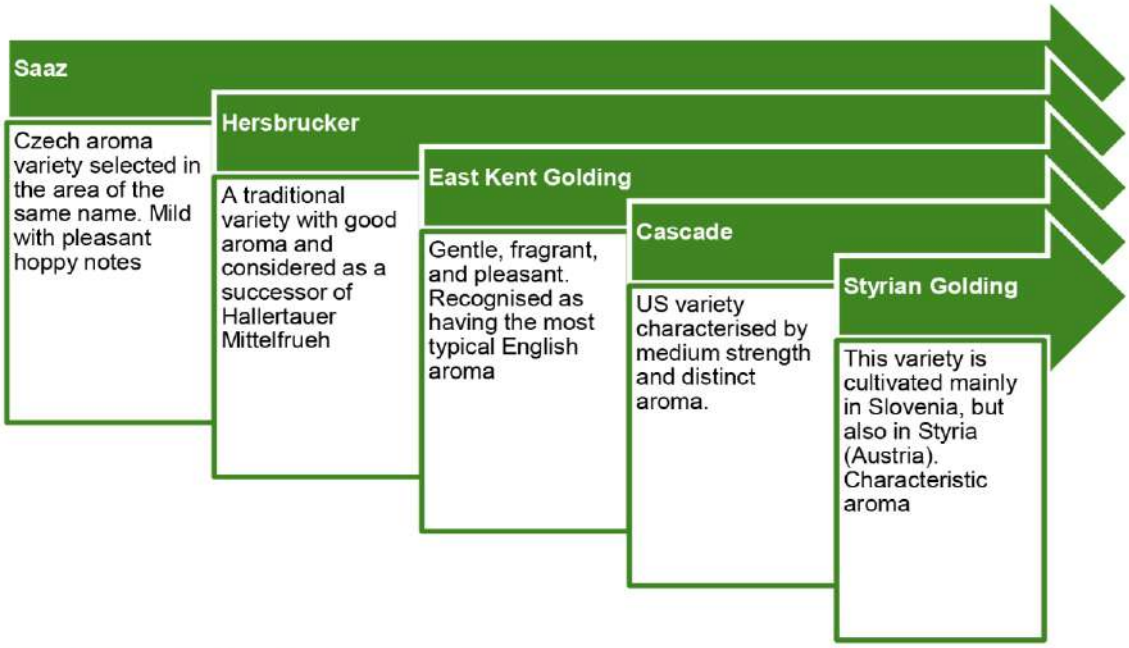

Figure 2: Examples from the PHA® varietal range

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Technical Support:

We will be pleased to offer help and advice on the use of PHA® in brewing/soft drink production.

UTILITIES ENGINEERING IN BREWERY

BIJAY BAHADUR

B.Sc. (Hons.); B.Tech. (Gold Medallist); PGDEE; FIE; Chartered Engineer (India) PE (ECI); LMIIChE; LMAFST (I)

Introduction

There are six utilities common to all breweries:

1. Steam
2. Water
3. Refrigeration
4. Electricity
5. Compressed Air
6. Carbon Dioxide

With the exception of CO_2 recovery and water treatment, utilities represent a source of energy supplied as needed in the brewing process and packaging operations.

The trend in new brewery project, as well as in the expansion of the existing brewery, is to very large units in order to take advantage of the economics of scale in construction and production. The demand for utilities increases with the size and scope of the overall brewing process. Large scale in utilities follows large scale in brewing increasing in complexity with the demand for energy conservation and environmental pollution abatement.

Brewery capacity, location and arrangement necessarily vary among competing breweries in the industry. However, the brewing processes, packaging operations and utilities supply are similar. Expansion in brewery capacity can be realized by process changes and equipment additions. Unit costs for utilities will be reduced if the expansion is properly planned.

Steam

The boiler is the heart of the steam generating plant. Water is evaporated in the drum of the boiler and distributed through piping to the users at pressure ranging from 7 - 15 Kg/cm^2. Average distribution is 8.78 – 10.54 Kg/cm^2.

At a point of use, the steam pressure is lowered through pressure reducing valve (PRV) to 2.8 – 3.2 Kg/cm^2 and passed into the coils or jackets which provide the hot surface for heating process liquids. The steam condenses to water into the coils or jacket and condensate is returned to the boiler for reuse as boiler feed water (recovery of condensate should be greater than 80%). Condensate is pumped into de-aerating feed water tank, make up water added as required, and steam injected to raise this temperature close to boiling. The water is then pumped into the boiler drum automatically to maintain a constant water level as loads vary in the system. Simultaneously, automated controls regulate theflow of fuel and air to the burner.

Boilers

There are two common types of boilers:

A. Water tube : Water inside tubes is heated by fuel burning in a furnace surrounded by the tubes.

B. Fire tube : Water in a boiler drum is heated by fuel burning inside tubes submerged in the water.

Furnace oil or natural gas is typical fuels. With proper operation, overall steam generating efficiency will be 80-85%. Stack emission will be clean and non-polluting with low sulfur fuels.

Fuel at about 90 ^0C is fed into the burner with air from a forced draft fan providing oxygen for combustion. Ignition is started by an electric spark. The burning fuel is blown to the rear of the furnace.

Sufficient air must be introduced to burn a maximum amount of the fuel to CO_2. An excess of air is required to ensure complete combustion, but too much will decrease the boiler efficiency by heating excess air not used in combustion. The % of CO_2 in the stack gas is a measure of efficiency. A high CO_2 content means low excess air, high efficiency and high stack temperature. Temperature must remain high enough to prevent water vapour, another product of combustion, from condensing inside the stack

Boiler Feedwater & Condensate Recovery

As heat is released in the mash kettle, wort kettle, bottle washer, and pasteurizer percolator the steam is condensed to hot water (condensate). Condensate is removed through trap that will pass water but not steam, and forced to return to a condensate receiver by the pressure power pump unit (PPPU) to feedwater tank.

Condensate return can be high pressure at 3 Kg/cm^2 or low pressure as discharged from a unit at 1Kg/cm^2. High- or low-pressure condensates are returned separately. Since not all steam is returned as condensate, make up water is added in the receiver (feedwater tank). Water is then pumped into a de-aerator, steam introduced to raise the water temperature and the gases vented out. This heated boiler feedwater is pumped into the boiler as required to maintain a constant level in the drum. The system is automatic and receiver and de-aeration are sized large enough to accommodate fluctuating demands for steam in the brewery.

Fuels

Oil (furnace oil), natural gas, and coal, biomass briquette are common fuels. Package boilers can be designed to use oil or gas by changing the burners. Coal and biomass briquette requires much additional handling equipment for unloading, storage, conveying and disposal of ash, plus dust collectors to remove particulates entrained in the stack gas. The choice of the fuels depends upon the availability and price, both of which are frequently influenced by government policy, as related to caloric value (CV) of each fuel.

Fuel	Average & Typical Range of Caloric V
Natural Gas	8900 – 9400 Kcals/m^3
Furnace oil	10667 – 11000 Kcals/Kg
Coal	5800 Kcals/Kg
Biomass Briquette	3800 Kcals/Kg

Caloric values vary with the source of fuel. The burning of low sulfur fuels is required by law.

Energy-Efficient Boiler Plant

A blow down economizer was added to the boilers to reclaim heat from excess boiler water and is used to preheat feed water for the boiler. By preheating the makeup water, the Btu/hr input of the boiler drops while the Btu/hr output remains the same.

The condensate of oxygen on the boilers is scrubbed before it returns to the boiler by a deaerator. This decreases the amount of boiler blow down and decreases makeup water, improving energy efficiency and requiring fewer chemicals to treat the makeup water.

Energy-Conserving Brew House

Process Heat: In the brew house, energy recovery reduces the need for steam. All of the heat for the brew house comes from steam supplied by two new, energy-efficient natural gas boilers. Heat lost from the boiling wort (unfermented beer) in the wort kettle is recovered and used to pre-heat future batches of wort with a vapor condenser on the exhaust stack. This translates into less energy demand, lower operational costs, and faster brew times!

Besides reducing energy demand, there is another benefit to energy recovery-steam from the kettle condenses into water. In this way, the vapor from the cooking beer stays in the brew house and the area outside of the brewery does not "smell like a brewery."

Water

Being a major raw material for the production of beer, water in a pure fresh supply is obviously important. Availability of water suitable for brewing has always held a high priority in the list of the factors considered in selecting a brewery project.

Almost every water supply will require some treatment before use in the brewery. The original source may be rivers, underground wells, lakes etc. Each will vary widely in chemical analysis and purity. Water analysis will determine the treatment required by the brewer. There are three general categories of water usage in the brewery:

1. Brewing
2. Boiler water (plus make up water)
3. Service which includes all other usage

Water Treatment

Depending upon the original water source, all or some of the following operations may be required in water treatment:

- Aeration : Oxidation for removal of odours, colours.
- Clarification : Addition of chemical for coagulation of suspended materials to cause settling prior to filtration or decantation.
- Filtration : Removal of suspended solids or turbidity by sand or by diatomaceous earth for higher clarity. Removal of oil.
- Chlorination : Excess chlorine addition to oxidize organic materials, remove bacteria.
- Carbon Filtration : Absorption by activated carbon for removal of odours, gases, organic chemicals, colour.
- Ozonation : Oxidation of organic impurities, bacteria.
- Demineralization : By cation and anion exchange resins for removal of mineral salts in waters with high total dissolved solids content.
- Rechlorination : Slight excess for bacteria removal.

Treatment of boiler feed water is usually needed to prolong the useful life of boilers; steam distribution and condensate return system. Maximum efficiency of operation, rapid response to fluctuating steam loads and low operating cost all require clean boiler interior surfaces. Feed water enters the boiler drum to replace water that has been evaporated to steam. If the water in the boiler does not contain excessive dissolved solids the steam generated will be free of all impurities except dissolved gases. As steam is used, the concentration of the dissolved solids increases and is held at an acceptable level by intermitted or continuous removal through blow down of water from the drum.

Boiler Problem & Correction

Almost all raw water sources require special treatment for removal of dissolved solids and gases before being used as boiler feed water. Impurities enter the system as make up water. Proper attention to boiler water chemistry will prevent major problems of corrosion and pitting of metallic surfaces, deposits of sludge and scale in boiler drums and tubes, foaming and carryover of impurities into the steam, and caustic embrittlement which causes crystallization and failure of metals.

Corrosion and Pitting are caused by the combined presence of dissolved oxygen and CO_2 in boiler water. Oxygen, librated by heat forms bubbles on metal surfaces. With CO_2 present iron and oxygen react chemically. Iron is dissolved, leaving a pitted, structurally weakened metal. Iron and water also react with heat reaching a stable chemical equilibrium. Oxygen, when present, prevents equilibrium and continuous metal corrosion results. CO_2, also librated by heat, leaves the boiler with steam causing corrosion in steam and condensate lines.

Corrosion and pitting are prevented by degasification in a deaerating feed water heater. Condensate and make up water are mixed in the condensate receiver (feed water tank) and transferred to the heater by pump pressure. The heater operates at 100 ^{0}C and above. The solubility of dissolved gases decreases with temperature increase; they come out of solution and are vented to atmosphere. High pressure steam from the boiler provides heat, and dissolved oxygen in the water is reduced to an acceptable level, 0.02 ppm.

Scaling and sludge deposits are controlled by treatment. Dissolved calcium and magnesium in the form of carbonates and sulphates cause hardness in water. When heated, insoluble carbonates are formed as scale in the drum and tubes. Scaling reduces tube diameter and slows heat transfer.

Foaming and Carryover are prevented by maintaining solids content and alkalinity within proper limits. Well-designed baffles within the drums are helpful.

Caustic Embrittlement is prevented by controlling alkalinity of the boiler water and by adding chemical inhibitors.

The steam from boilers so treated obviously cannot be used for direct injection into the product.

Refrigeration

Refrigeration plant is of central importance in a brewery. With about 40%, refrigeration is one of the largest electrical power consumers and refrigeration directly influences beer quality. The final product is decisive; refrigeration is an essential tool. The right refrigeration capacity at the right time in the right place.

In the brewery, refrigeration is used for cooling beer, chilled water for wort cooling, brine (propylene glycol or industrial alcohol) for attemperation and maintaining low temperatures in the cellars and hop storage rooms. Refrigeration is a process for removing heat from a space or substance, to bring about a reduction in temperature, by transferring that heat to another substance.

Refrigeration Cycles

Most refrigerants undergo a series of evaporation, compression, condensation, throttling, and expansion processes, absorbing heat from a lower-temperature reservoir and releasing it to a higher temperature reservoir in such a way that the final state is equal in all respects to the initial state. It is said to have undergone a closed refrigeration cycle. When air or gas undergoes a series of compression, heat release, throttling, expansion, and heat absorption processes, and its final state is not equal to its initial state, it is said to have undergone an open refrigeration cycle.

A. Compressor

A refrigeration compressor is the heart of a vapor compression refrigeration system. Its function is to raise the pressure of the refrigerant and provide the primary force to circulate the refrigerant. The refrigerant thus produces the refrigeration effect in the evaporator, condenses into liquid form in the condenser, and throttles to a lower pressure through the throttling device.

B. Condenser

The purpose of the condenser is to remove the amount of heat that is equal to the sum of the heat absorbed in the evaporator and the heat produced by compression. There are many different kinds of condenser.

C. Expansion Valve

The main purpose of the expansion valve is to ensure a sufficient pressure differential between the high and low-pressure sides of the plant. The simplest way of doing this is to use a capillary tube inserted between the condenser and evaporator.

D. Evaporation Systems

Depending on the application, various requirements are imposed on the evaporator. Evaporators are therefore made in a series of different versions. Evaporators and controls including space coolers for cellars and process cooling – beer, brine (propylene glycol, industrial alcohol etc.)

Unit of Refrigeration

Unit of refrigeration widely used in the industry is Ton of Refrigeration, or simply Ton. 1 ton = 12,000 Btu/hr of heat removed. This equals the heat absorbed by 1 ton (2000 lb) of ice melting at a temperature of 0 0C over 24 hrs or a ton of refrigeration is 12000 BTU/hr which is amount of refrigeration required to make a 1 ton (2000 lb) of ice in 24 hours.

Because the heat of fusion of ice at 0 ^{0}C is 144 BTU/lb,

$$1\ \text{Ton} = \frac{1 \times 2000 \times 144}{24} = 12,000\ \text{BTU/hr}$$

Also, 1 ton = 3.516 kW

Refrigerant Safety

Refrigerant hazards stemming from leaks in the pipe joints, the rupture of system components, and the

burning of escaping refrigerant depend on the type of refrigerant, and the refrigeration system.

Storage of Refrigerants

Refrigerants are usually stored in cylinders during transport and while on site. During storage, the pressure of the liquid refrigerant must be periodically checked and adjusted. Excessive pressure may cause an explosion. Liquid refrigerants must not be stored above 54.4°C, although the containers are designed to withstand up to 3 times the saturated pressure at 54.4 °C. If a container bursts, liquid refrigerant flashes into vapor. Such a sudden expansion in volume could cause a violent explosion inside a building, blasting out windows, walls, and roofs.

Containers should never be located near heat sources without sufficient ventilation. They must also not be put in truck in direct sunlight. The valve of the container is attached by thread only. If the threads are damaged, the force of escaping vapor could propel the container like a rocket.

According to ASHRAE Standard 15-1994, in addition to the refrigerant charge in the system and receiver, refrigerant stored in the plant shall not exceed 150 kg. The receiver is a vessel used to store refrigerant after the condenser when necessary.

Refrigeration Plant

A refrigerating plant is an enclosure with tightly fitted doors to safely house compressors, refrigeration components, and other types of mechanical equipment. A refrigerating plant must be designed so that it is easily accessible, with adequate space for proper servicing, maintenance, and operation. A refrigerating plant must have doors that open outward and are self-closing if they open into the building; there must be an adequate number of doors to allow easy escape in case of emergency.

According to American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 15-1994, a refrigeration plant must meet the following requirements:

- It must be ventilated to the outdoors by means of mechanical ventilation using power-driven fans or multiple-speed fans. Provisions for venting catastrophic leaks and component ruptures should be considered.

- There must be no open flames that use combustion air from the machinery room except matches, lighters, leak detectors, and similar devices.

A refrigerating plant of special requirements must meet the following specifications in addition to the general requirements:

a) Inside the room, there must be no flame-producing device or hot surface continuously operated at a surface temperature exceeding 427°C.

b) There must be an exit door that opens directly to the outdoors or to a similar facility.

c) Mechanical ventilation for ammonia must be either continuously operating or equipped with a vapor detector that actuates a mechanical ventilation system automatically at a detection level not exceeding 4% by volume.

d) It must be provided with remote pilot control panel immediately outside the refrigeration plant to control and shut down the mechanical equipment in case of emergency.

Because the refrigerating plant itself is a fire compartment, the building structure and its material (including the door, wall, ceiling, and floor) should meet National Fire Protection codes. In a refrigeration plant, there are general and special requirements. The installation of mechanical ventilation and an oxygen or vapor sensor is mandatory.

CO_2 Gas Recovery

Introduction

CO_2 recovery plant is an important factor ensures optimum beer quality. Beyond that, CO_2 recovery also offers significant potential for cost savings and contributes to an ecologically responsible production.

Brewers are aware that how important the purity of the CO_2 is for the quality of the final beer. Even the least amount of residual oxygen in the CO_2 has a detrimental effect on the flavour stability of the beer. The utilization of CO_2 from the own fermenters guarantees perfect quality–an advantage that no other source can offer.

Carbon dioxide in the brewery is generated by the yeast during fermentation, together with heat and alcohol. Because CO_2 is required at the end of the beer manufacturing process such as carbonation i.e. to add the fizzy effect to the final beer and purging process tanks, it reduces costs by recovering it during fermentation. Nevertheless, great care needs to be taken to avoid contamination of the final beer by air. Oxygen in final beer reduces the product shelf life and contributes to off tastes.

Additionally, a maximum CO_2 recovery yield is expected from this process. Today purities of around 99.998% can be achieved with the latest CO_2 recovery plants.

CO_2 from Fermentation

CO_2 gas is generated as a by-product of the breweries fermentation process. This then is collectively reclaimed from the fermentation area through adequately sized collection pipe lines for common feed to the CO_2 gas recovery system. The gas at this point will be at low pressure and combined purity of > 98.5%.

CO_2 Collection and Recovery

Collection of CO_2 should start after 24 hrs from the start of fermentation (initially CO_2 should be vented out) and stop collection when the gravity falls to 5.0 - 4.5 ^{0}Plato.

The recovery plant compresses CO_2 gas, elevating the pressure to approximately 18 Kg/cm^2 for Co_2 gas processing that being: washing, purifying, drying and CO_2 gas condensing.

Once compressed, CO_2 gas is treated for removal of impurities typical of these sources by high pressure high efficiency CO_2 gas washing (scrubbing) providing a CO_2 purity of min 99.9 %.

System further enhances the gas quality by proper CO_2 gas purifying. This is accomplished by an activa ted desiccant bed for gas drying to a dew point of -40 °C at pressure followed by carbon polish filter, again subject to raw gas and process conditions. Once the operation is completed, the final gas will be odour free, colour free and taste free, preparing for the last stages of purification.

As a means of final purification, the CO_2 gas is condensed (separation of non-condensable gases). Co_2 gas condensing is accomplished by use of an independent refrigeration system that liquefies CO_2 gas at approximately 18 Kg/cm^2 and -24 °C. The non-condensable gases present in the CO_2 gas are separated and purged from the system automatically and reused for regeneration gas within the plant.

Liquid CO_2 leaving the CO_2 condenser flows by gravity to a liquid CO_2 purification system to achieve a final liquid CO_2 purity of 99.998 %. Thereafter, high quality liquid CO_2 is pumped to a liquid Co_2 storage tank for handling the liquid CO_2 for use for beer carbonation.

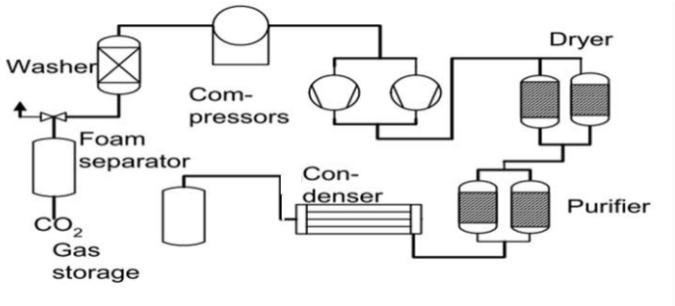

Figure 1: The Standard Method for CO_2 Recovery

Compressed Air

Compressed air systems are the most important utility in breweries and are often the most misunderstood. It is essential for the brewers and engineers to provide an understanding of common compression systems and operation techniques in breweries.

The interconnecting aspects of a compressed air system and to show advantageous solutions to problems that arise when planning and operating such systems properly. The planning of a compressed air system must be carried out carefully, using a comprehensive layout of information and criteria that can be clearly understood.

Usages of Compressed Air in the Brewery:

- To push fluids through piping and empty tanks, in the form of dry, oil-free, sterile air.
- To aerate wort, yeast, or water, in the form of dry, oil-free, sterile air.
- As an energy carrier for the pneumatic transportation of solids, such as spent grains, whole malt, sugar, and filter media, in the form of oil-free, and where necessary, dry air.

- As a purge gas to displace CO2 from tanks prior to being cleaned-in-place (CIP) with caustic, in the form of oil-free, sterile air.
- To modulate valves in valve control operations, in the form of dry, oil-free air.
- As an energy carrier to drive air tools, in the form of dry air.
- Plant maintenance and control.

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How parts per million of ions are estimated from grams of brewing salt dissolved in water.

SAURABH N. PERKAR

BREWER
ALCHEMY MICROBREWERY, BANGALORE

We have been looking at many waters chemistry example to estimate residual alkalinity of water And its effect on mash ph.
But do we know how parts per million of ion concentration from choice of salt is contributed in water. On which factor is depends, how to choose those factors to get exact results.

Those 2 primary factors are atomic weight of individual ion contributed and molar mass of choice of salt.

As we know calcium sulphate dihydrate contribute calcium and sulphate ion.

Calcium chloride dihydrate contribute calcium and chloride ion.

Magnesium sulphate heptahydrate contribute magnesium and sulphate ion.

Sodium chloride contribute sodium and chloride ion.

Sodium hydroxide contribute sodium and bicarbonate ion.

And calcium carbonate contributes calcium and carbonate ion.

But now a major question is how to get target ppm of choice if contributed ion from choice of brewing salt.

As we have mentioned above that it all depend on atomic weight of ion and molar mass of salt.

Let's understand it with and example,

Let's suppose we have 100 Liter of distilled water which doesn't have any ion and we want to increase its calcium ion concentration from zero to 20 ppm and at the same time we want to see how much chloride will be dissolved with estimated quantity of salt. And our choice of salt is calcium chloride dihydrate.

So, first step is to convert ppm into gram per Liter which in this case will be 0.02 g/l.

And atomic weight of calcium is 40.078 gram per mol.

Using gram per Liter concentration and atomic weight we need to calculate molar or moles per Liter concentration. Which in this case is 4.99 * 10^ -4

Now as we have our molar concentration data, we need to find no of moles needed in per unit of volume. And as mentioned above we have 100 Liter water.

From molar and volume of water our calculated no. of moles will be 0.0499

And for the final step we know molar mass of calcium chloride dihydrate is 147.01 g/mol.

And mol dissociation ratio is 1 so from 0.0499 moles and molar mass 147.01 g/mol we need 7.335 gram of calcium chloride dihydrate for 100 liter of water to raise 20 ppm of calcium ion concentration.

Exciting isn't it? But what if we can go back in reverse with same steps to calculate chloride ion concentration.

So now we need to back to that step where we knew molar concentration.

Our molar cocncentarion was 4.99 * 10^ -4 and chloride atomic weight is 35.453 g/mol.

So we will get 0.0176 gram per liter concentration which when converted to ppm is 17.69 chloride ion concentration.

So today we have look at very basic steps to estimate ppm of ion concentration from weight of salt and vice versa and this steps are applicable for all kind of brewing salt but only catch is that we should know atomic weight of ions , mol dissociation ratio and molar mass of salt.

I hope this example was helpful and next time we can have and example with multiple salts and its effect on sulphate to chloride ratio.

Till the next time , cheers to brewing amazing beers.

AGING OF HOPS & EFFECT ON BEER

AKSHAT JAIN

Business Development Manager-Craft Brewing

Hops are a crucial ingredient in beer brewing and contribute significantly to the flavor, aroma, and bitterness of the final product. The aging of hops can have both positive and negative impacts on their contribution to beer flavor. Here's how aging affects hops and their role in beer:

1. Aroma and Flavor Compounds: Hops contain essential oils and other volatile compounds responsible for the characteristic aromas and flavors in beer. As hops age, these compounds can degrade, leading to a reduction in their potency and complexity. This may result in a loss of desirable hoppy aromas and flavors.

2. Bitterness: Hops also contribute bitterness to beer, which helps balance the sweetness of the malt. The alpha acids in hops are responsible for the bitter taste. Over time, these alpha acids can degrade and reduce the beer's overall bitterness.

3. Storage Conditions: Proper storage is crucial to maintaining hop quality. Exposure to heat, light, and oxygen can accelerate the degradation of hop compounds. Brewers often vacuum-seal and store hops in a cool, dark place to preserve their freshness.

4. Staling: Just like beer can go stale, hops can also experience staling. Staling occurs when hops undergo chemical changes over time, leading to a deterioration in their aroma and flavor characteristics.

5. Aging for Special Beers: While fresh hops are generally preferred for most beer styles, some brewers intentionally age hops to create unique flavors. For instance, certain Belgian-style ales and barrel-aged beers benefit from using aged hops to impart distinct qualities.

6. Dry Hopping: Dry hopping is a technique where hops are added to the beer during or after fermentation. This method is often used to enhance the beer's aroma. If aged hops are used for dry hopping, they may provide subtle and mellowed aromas to the beer.

7. Hop Selection: Hop growers and brewers carefully select hop varieties based on their intended use. Some hops are known for their aging potential, while others are best used fresh to maximize their aromas and flavors.

In summary, the aging of hops can impact their aroma, flavor, and bitterness in beer. While fresh hops are generally preferred for most beer styles, aged hops can be utilized intentionally for specific beer types or brewing techniques. Proper storage and hop selection are crucial to maintaining hop quality and ensuring they contribute positively to the overall beer flavor.

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THE IMPORTANCE OF SELTZER IN THE BEER INDUSTRY AND ITS MARKET DEMAND AND TRENDS

PRADEEP DWIVEDI

CEO of Nutrelis Agro Foods, Noida
Email – info@chicoree.in
Mobile - 9599438851

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Introduction

Seltzer, a carbonated water beverage with various flavors, has witnessed a remarkable surge in popularity in recent years. While traditionally associated with the soda industry, seltzer has also made a significant impact in the beer industry. This article delves into the importance of seltzer in the beer industry, examining its market demand, consumer preferences, and the factors driving its growth. By exploring the intersection of seltzer and the beer industry, we can gain insights into the evolving beverage landscape and the opportunities it presents. Seltzer is a carbonated water beverage that is often flavored. It is similar to soda or sparkling water but typically does not contain any added sugars or artificial sweeteners. Seltzer is known for its effervescence and refreshing qualities. It can be enjoyed on its own or used as a mixer in various cocktails.

1. The Emergence of Seltzer in the Beer Industry

1.1 Changing Consumer Preferences: The rise of health-consciousness and the increasing demand for lighter, lower-calorie options have driven consumers to explore alternative beverages. Seltzer, with its low-calorie content and refreshing taste, has become an appealing choice for individuals seeking a lighter alcoholic option.

1.2 Diversification of Beer Offerings: Brewers have recognized the shifting consumer preferences and the need to diversify their product portfolios. By incorporating seltzer into their offerings, beer companies have expanded their reach and tapped into a new market segment that was previously untapped.

1.3 Appeal to New Consumer Segments: Seltzer's clean and crisp taste, coupled with its fruitflavored options, has attracted consumers who may not have been traditional beer drinkers. This includes younger demographics and individuals who prefer milder alcoholic beverages.

2. Market Demand for Seltzer in the Beer Industry

2.1 Growing Market Size: The market demand for seltzer in the beer industry has witnessed exponential growth. Brewers and beverage companies are investing in seltzer production facilities and expanding their product lines to meet the rising consumer demand.

2.2 Millennial and Gen Z Influence: Millennials and Gen Z consumers have played a significant role in driving the popularity of seltzer in the beer industry. These demographics prioritize convenience, variety, and healthier options, making seltzer a natural fit for their preferences.

2.3 Health-Conscious Lifestyle: Seltzer's lower calorie and carbohydrate content align with the increasing emphasis on health and wellness. Consumers seeking healthier alternatives to traditional beer are turning to seltzer as a refreshing option.

2.4 Flavor Innovation: The seltzer market in the beer industry is characterized by a wide range of flavor options, from classic fruit flavors to more unique and exotic combinations. This flavor innovation has contributed to the overall appeal and market demand for seltzer.

2.5 Accessibility and Convenience: The ready-to-drink nature of seltzer, often available in portable cans, has contributed to its market demand. Seltzer's convenience aligns with consumer preferences for on-the-go lifestyles and social gatherings.

3. Impact on the Beer Industry and Future Outlook

3.1 Industry Adaptation and Expansion: The emergence of seltzer in the beer industry has prompted brewers to adapt and expand their operations. Many breweries have introduced their own seltzer brands or acquired existing seltzer producers to capitalize on the trend.

3.2 Market Competition and Collaboration: The growing seltzer market has intensified competition within the beer industry. Breweries are competing to capture a share of the seltzer market by offering unique flavors, marketing strategies, and brand differentiation. Additionally, collaborations between beer and seltzer brands have emerged, leveraging each other's strengths to create innovative products.

3.3 Sustaining Consumer Interest: To sustain the demand for seltzer in the beer industry, breweries must continue to innovate and anticipate evolving consumer preferences. This includes flavor experimentation, product differentiation, and engaging marketing campaigns that resonate with target demographics.

3.4 Regulatory Considerations: As the popularity of seltzer grows, regulatory bodies may introduce guidelines or regulations specific to seltzer production and labeling within the beer industry. Brewers will need to stay informed and compliant to ensure consumer safety and product quality.

Conclusion

Seltzer has become an essential component of the beer industry, driven by changing consumer preferences, market demand, and the need for diversification. Its lower calorie content, refreshing flavors, and appeal to new consumer segments have made seltzer a significant growth opportunity for brewers. As the seltzer market continues to expand, the beer industry must adapt, innovate, and collaborate to meet consumer expectations. By embracing the rising popularity of seltzer and capitalizing on its market demand, breweries can navigate the evolving beverage landscape, capture new consumer segments, and ensure their relevance in the dynamic market of the future.

ROLE OF ENZYMES IN BREWING INDUSTRY

DR. VASUDEO P. ZAMBARE

R&D and Technical Head

Balaji Enzyme and Chemical Pvt Ltd,
Andheri (E), Mumbai, Maharashtra, INDIA

ABSTRCT

Though brewing is an ancient process but with the technological advancement it has been developed a lot. Worldwide, brewing is one of the leading food industries, where enzymes play a crucial role. These enzymes might be secreted in the kernel or added externally for quality beer. Thus, this article mainly focussing on the brewing process flow and the role of enzymes in the brewing steps along with its mechanism of action.

Keywords: Enzyme; Brewing; Malting, Mashing, Hydrolysis; Saccharification; Fermentation

INTRODUCTION

Enzymes are biocatalysts and that enhances the biochemical reactions and is on tremendous demands in food and beverage industries. Enzyme controls metabolic (catabolic and anabolic), signalling, cell regulatory processes. All enzymes are protein and mainly present in folded form containing combinations of metal and one or more primary protein containing thousands of amino acids linked by peptide bonds. Thus, considering the physiological properties, enzymes have important role in food and beverage industries. Such enzymes are in use in food processing since its ancient age and some of them are with its potential applications are summarized in Table 1 (Khan and Sathya, 2017). Among these applications, enzymes in brewing are on high demand. Brewing is nothing but beer production where sugars are fermented to ethanol via yeast fermentation. Nowadays, brewing industry is growing exponentially and is leading among the food industry. The worldwide sales value of beer US$610 billion in 2022 is expected to increase to US$754 billion by 2027 (Statista, 2023). Worldwide, 180,333 metric tonnes of beer are produced annually and largest producer is China (27.6%) followed by USA (12.5%), and Brazil (7.8%) (Atlasbig, 2022) Thus, the aim of this article is to understand the brewing process flows and to understand the mechanism of action of various brewing enzymes.

Table: 1 Enzymes and their applications in food (Khan and Sathya, 2017)

Enzyme	Applications in Food Industry
Beta-glucanase	Brewing industry
Protease/ Papain	Meat tenderization, protein hydrolysis, wheat gluten hydrolysis
Amylase	Starch liquefaction, high fructose syrup, dextrin to fermentable sugar, bakery
Cellulase	Starch liquefaction, maltose, high fructose syrup, dextrin to fermentable sugar
Xylanase	Bakery industry, xylo-oligosaccharide synthesis
Beta galactosidase	Bakery, production of galacto-oligosaccharide
Lipase	Food, dairy, poultry feed
Pectinase	Fruit juice, wine; pecto-oligosaccharide synthesis

BREWING PROCESS

Brewing process is an integration of 9 steps of malting, milling, mashing, lautering, hoping, fermentation, conditioning, filtering, and canning or bottling (Figure 1). Malting is the process where the wheat/ barley grains are converted into dextrin and maltose using water, heat, and combination of enzymes (alpha-amylases and proteases) by three processes of stepwise increasing temperatures such as steeping (14 to 18°C), germination (16 to 20°C), and kilning (50 to 110°C). A homogeneous malt was prepared by adding water followed by its grinding which further hydrolysed into simple sugars by milling and mashing process. The end product of mashing process is called wort which further processes through lautering where the grains are filtered off from the sugar solution in a lauter tank. Hoping is the process of addition of hops into the wort which improves the beers flavour and stability by boiling to 100°C. Cooled down the wort to 25°C by aeration for yeast fermentation of sugar to ethanol and carbon dioxide to produce the beer. Further, the beer is conditioned by lowing the temperature to –2 to 0°C where harmful and unwanted particles will be removed for better carbonation, aroma, and beer taste. Filtered off the beer through filter aid to remove the suspended solids of hops, barley grains, and yeast, etc. Finally, and most critical step is to remove the oxygen from the beer to avoid the spoilage of beer and then packing into the cans, kegs or bottles. All these steps are important in brewing where enzymes play a crucial role and below section explains the role and action of each enzyme during brewing process.

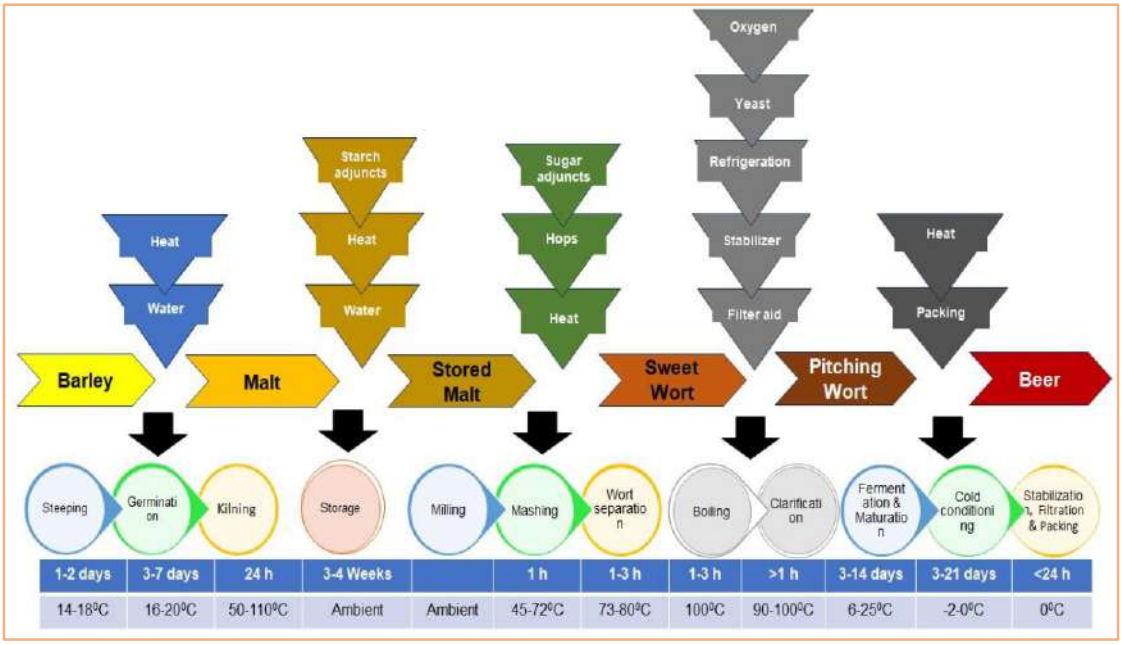

Figure 1: Schematic diagram of malting and brewing operation along with its process duration and operating temperatures (Gomaa, 2018).

Endogeneous enzymes (Barley kernel enzymes)

Endogeneous enzymes are synthesized or secreted in the barley kernel during its malting process. Brewing is the process of soaking of barley starch in water followed by yeast fermentation to beer alcohol. All these steps are enzyme catalysed and the most widely used source was barley. A schematic diagram showed secretion of different forms of enzymes in barley (Figure 2). The barley kernel itself secretes most of the brewing enzymes (protease and glucanase) when the kernel is soaked in hot water (Sammartino, 2015). As mentioned, earlier malting has three steps of steeping, germination, and kilning. During steeping the barley is soaked in water for two days to absorb moisture and then began the germination in next 3-7 days where the barley is converted to malt. Kilning is the process where germination is stopped by drying the malt which changes the moisture, color, and flavor. Further, starch gelatination occurs by malt mashing under hot water. In brewing, the starch is supplied by two sources of barley and other starch material. The starch hydrolysed by enzymatic action on amylose and amylopectin chains. Alpha-amylase hydrolyses starch to dextrin called starch liquefaction. Further, enzyme converts starch and dextrins into glucose called saccharification. Thus, the use of saccharifying enzyme is dependent on the quality of beer. For example, glucoamylase for light beer production. Use of some other commercial enzymes during mashing results into various but desirable products.

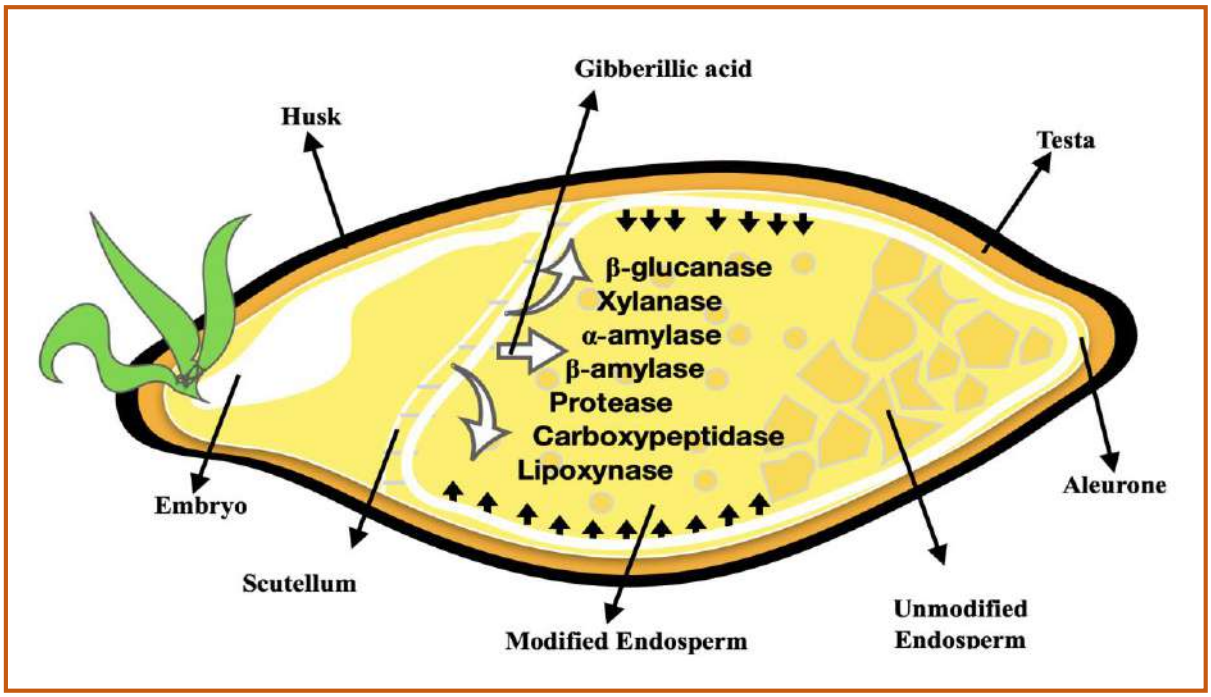

Figure 2: Brewing enzyme secretion in barley kernel (Gomaa, 2018)

Exogeneous enzymes

Exogenous enzymes are externally added enzymes for top up the maximum saccharification, higher yield and better quality beer production. Enzymes used in brewing processes are with different actions and characteristic. Four major brewing steps of germination, mashing, fermentation and clarification where 4 enzymes (glucanase, protease, alpha amylase, and beta amylase) are widely used (Sammartino, 2015). These enzymes either expressed endogenously in kernel or can be suppled externally. Externally supplied enzyme are commercial enzymes and most probably used it for furnishing the better-quality product in terms of clarity, color, texture, and flavor.

Most of the brewing processes are supplied with external enzymes as the endogeneous enzyme expression levels during barley mashing are not enough to breakdown the starch/ sugar to fermentable sugars and further to ethanol fermentation. Ultimately, the affecting the product yield and low-quality beer manufacturing. Malting process is performed with proteases, glucanases, and xylanase enzymes and are breaking down proteins, β-glucan, and fibers, respectively. Thereafter, the starch gelatinization with hot water, an enzyme amylase converts the wort to fermentable sugars via starch liquefaction and saccharification. Furthermore, more α-amylase and β-glucanase enzymes can be reused for improved fermentation yield. The fermentation process can be speed-up by using alpha acetolactate decarboxylase (ALDC) and protease enzyme for better quality and clear beer during cooling and chilling operations of beer. Table 2 summarizing the list of brewing enzymes and their sources. In addition to this Table 3 showed list of brewing enzymes deals in Indian and international market by Balaji enzyme and Chemical Pvt Ltd, Mumbai, INDIA.

Table 2: Brewing enzymes and their effects

Enzyme	Sources	Process	Function	References
Alpha amylase	Barley kernel *Bacillus licheniformis*	Malting Mashing	Starch hydrolysis Improve clarification	Guerra *et al.* 2009
Beta amylase	Barley kernel Wheat kernel *Bacillus licheniformis*	Malting Mashing	-Starch hydrolysis -Improve malting -Improve saccharification -Increase fermentation yield	Guerra *et al.* 2009
Fungal alpha amylase	*Aspergillus oryzae*	Malting Mashing Fermentation	-Breaks down gelatinized starch to dextrins and maltose	Underkofler *et al.* 1941
Beta-glucanase	Barley kernel *Trichoderma* sp.	Mashing Mashing Fermentation	-Improve malting -Lower viscosity -Improve clarification	Vatandoust *et al.* 2012
Amyloglucosidase (Glucoamylase)	*Trichoderma reesei* *Aspergillus niger*	Mashing	-Increase the amount of glucose in the wort for light beer production	Jing *et al.* 2013
Protease	Barley kernel *Aspergillus* sp. Pineapple latex Papaya latex	Malting Mashing	-Improve malting -Improve fermentation -Improve clarification -Improve chilling and storage quality	Faulds *et al.* 2009; Piddocke *et al.* 2011
Fungal acid protease	*Aspergillus oryzae*		-Protein hydrolysis -Increase free amino nitrogen for yeast growth	Rubio-Flores *et al.* 2020
Alpha acetolactate	*B. subtilis* recombinant	Fermentation	-Reduce fermentation time	Dulieu *et al.* 2000
decarboxylase (ALDC)				

Table 3: Brewing enzymes deals by Balaji Enzyme and Chemical Pvt Ltd

Brand Name	Enzymes	Function
ALPHALASE® AP4 **ALPHALASE® Advance 4000**	Enzyme complex of alpha amylase, β (1,3) 1,4 glucanase, neutral protease	-Consistent mashing -Improve extract yield -Higher adjunct inclusion -Increase soluble protein and free amino nitrogen -Reduce energy consumption
ALPHALASE® THP	Neutral protease	-Increase free amino nitrogen -High adjunct inclusions to mash
AMYLEX® 5T	Thermostable alpha amylase	-Starch liquefaction and extraction -Reduced viscosity
DIAZYME®TGA	Glucoamylase	-Increase fermentability -Production of light beer (low carbohydrate)
DIAZYME® FA	Fungal alpha amylase	-Improve malting -Increase fermentability -Improve clarification
LAMINEX® MaxFlow 4G	Xylanase and β glucanase	-Reduce wort viscosity -Improve wort separation and beer filtration

Amylase

Amylases are mainly used in malting processes which breakdown complex polysaccharide of starch to alpha glucose molecules of dextrins, oligosaccharides (maltose) or simple glucose (Guerra et al. 2009). Not only alpha amylase is used but also beta-amylase is also used for conversion of starch to fermentable sugar of brewing operations. Alpha amylase (α-amylase) breaks the internal α (1-4) glycosidic bonds between the α-glucose molecules and form large linear chain starch (amylose) and branch chain of starch (amylopectin) into dextrins whereas beta amylase (β -amylase) catalysis the hydrolysis of amylose and amylopectin into maltose by breaking the external α (1-4) glycosidic bonds. During malting process, α and β -amylase are released from the starch granules after the action of β-glucanases and xylanases enzyme on outer sheath of starch granule. Both alpha and beta amylases acting continuously on starch wort to simple sugars in mashing steps and which were further fermented to alcohol. Controlled use of amylases affected the beer quality. Concentration of sugar is important for alcohol production. Higher the sugar concentration higher is the alcohol concentration whereas low sugar or amylase wort showed low ethanol in beer. The optimum levels of temperature and pH for both alpha and beta amylases were 74 and 63 °C °C and pH 5.2 and 5.5, respectively. Both enzymes can perform at same temperature but will different efficiencies as its temperature optima is different. Generally, for excellent starch liquefaction, α-amylase with a recommended dose of 1-2 kg of the enzyme per ton of barley was used. However, for β-amylase dose is varying and it depends upon the type of sources.

Beta glucanase

β -glucanase is one of the key enzymes in the brewing operations of malting and mashing. β -glucanase is a cellulase type enzyme that degrade the outer shell of starch granule and other hydrolytic enzymes were acted on the internal starch components after opening the starch granules in hot water.

Generally, β-glucanase hydrolyzes the 1-3 β-glycosidic bonds between glucose molecules in glucans (Vatandoust et al. 2012). Thus, the reactions are necessary in beer industry because it reduces the wart viscosity and soften the kernel during germination by proteolytic hydrolysis of starch granule matrix. β-glucanase expressed endogeneously within the barley and is called endo- β 1, 3-1, 4-glucanases, however β–glucanase is now commercially produced from microbial fermentations. Microbial originated β-glucanases are used for production of light beers in short maturation time which improves the texture and light quality of beer. Sometime, turbid beer is also necessary especially in craft beer and was clarified as an extra step by using β-glucanases. Here, β-glucanase breaks the turbidity toproduce the haze beer with binding of proteins bonded to polyphenols, β-glucans, and starch). The enzyme dose used for wort conversion was 0.3-1 kg per ton of the wort material. Thus, a promising β-glucanase must have optimum levels of temperature and pH activity and stability at 45 - 50°C and 6.0, respectively. and denaturizes at 60°C which is common as 45°C is known to be the lowest optimal temperature for enzymes that hydrolyzes cell walls.

Fungal alpha amylase

Fungal α-amylase (FAA) convert the grain starch into fermentable sugar (maltose) during mashing operation of brewing. Most commonly produced FAAs are from Aspergillus oryzae.It prevented the starch/dextrin turbidity in the finished beer and the organoleptic properties (clarity, color, texture, and flavor, smell) of the beer remain unchanged. The recommended dose of FAA was 1 to 4 g per hectolitre at 60°-65°C and further deactivated above 70°C.

Amyloglucosidase (Glucoamylase)

Amyloglucosidase (glucoamylase) is a food grade saccharifying enzyme produced from Trichoderma reesei and Aspergillus niger stains. It hydrolysing both the α-1,6 and α-1,4 glucosidic linkages of starch, liberating single glucose units. Generally, glucoamylase is unstable in mashing saccharification temperature and hence brewer produced super-attenuated beer using glucoamylase for hydrolysis of wort carbohydrates. This process involves the cooling of raw (un-boiled) wort at 60^0C with glucoamylase dosing for the period of 4h (Matthews et al. 2000). Maximizes the conversion of starch containing substrates to fermentable sugars high degree of attenuation with dosage of 3-5 g per hectoliter wort during fermentation. It produces low carbohydrate (calorie) beers ad also called light beer.Glucoamylase used in between pH 3.5-5.0 and a temperature between 20-70^0C and further inactivated by heating at 95^0C for 10 minutes or at 100^0C for 3 minutes.

Protease

Protease cleaves the peptide bonds of protein and has important role in brewing where it degrades the protein for clarification and increase malting efficacies. Protease not only enhances the protein solubility and reduces the beer viscosity but also provide amin acids for yeast growth. The proteinaceous kernel layer was softened or hydrolysed by protease enzyme and exposed the starch with mashing enzymes for better mashing performance and wort fermentability (Lei et al. 2013). Protease dosing and activity must be carefully monitored as it may affect the foaming properties of beer. Protease used in brewing processed showed optimum pH 10 and temperature is 52ºC and inactivated above 70ºC. Every barley kernel produces its natural protease but always need to supply the external protease to maintain the protease level for better quality beer.

Sometimes the overdosing of protease causes undesirable effect of the enzyme degradation and foam instability. The protease dose used for mashing operation of brewery was 0.3 – 1 Kg per one tone of barley.

Plant based protease enzymes such as papain, and ficin also most predominantly used in brewing processes. Ficin and papain enzymes were extracted from fig (Ficus insipida) and papaya (Carica papaya) latex, respectively. These plant enzymes hydrolyse the protein responsible for chilling haze and hence called chill-proof enzymes. These chill proof enzyme removes high molecular weight polyphenols and polypeptides by hydrolysis which results into the disappearing of the haze material. These enzymes are quite thermostable (60 – 65°C). The dose 1 to 2 grams per one hectoliter of beer either storing vessels or before beer filtration was used and is varied based on its sources.

Alpha-acetolactate decarboxylase

Apart from beta glucanase, amylase, and protease, some other lyase enzyme alpha-acetolactate decarboxylase (ALDC) is also being used for brewing process for better quality beer its processing, storage, and transportation. ALDC enzyme generally used for high yield under lower fermentation time without disturbing the beer quality (Dulieu et al. 2000). ALDC catalyses the α-acetolactic acid to acetoin. The optimum pH, and temperature of ALDC is in between within 5-7 and 25-40°C, respectively. The effective dose of ALDC is 1-5 grams per hectoliters of the wort at the time of initiation of fermentation or 0.4-1.0 grams per hectoliter of wort when added after fermentation.

CONCLUSIONS

Enzymes play a crucial role in brewing processes and it can-not be skipped in future. Enzymes are biocatalysts and regulates the various metabolic and molecular reactions for food synthesis. Enzymes such as proteases, amylases, cellulase, and glucanase are important for the beer production. Saccharifying enzymes are important for brewing operation of malting and mashing which were either secreted endogeneously in barley kernel or supplied externally. Overall, enzymatic process increases maximum saccharification, high fermentability ability, viscosity reduction, protein solubilization for yeast growth, ethanol fermentability and clarification of quality beer.

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Unlocking India's Potential for Advanced Biofuels: The Promise of Lignocellulosic Ethanol

Sachin Mogal

Technical Manager (Alcohol) ,
Balaji Enzyme and Chemical Pvt ltd

You know India has a serious energy problem. With a rapidly growing population and economy, India's demand for oil is skyrocketing. But as an importer of nearly 80% of its oil, India's economy is vulnerable to price shocks and supply disruptions on the global market. What if there was a homegrown solution? There just might be. Turns out India has abundant agricultural residues and waste that can be converted into ethanol fuel. We're talking about things like corn stalks, wheat straw, and rice husks. Through a process called lignocellulosic ethanol production, these waste materials can be broken down into simple sugars and then fermented into ethanol. If developed and scaled, lignocellulosic ethanol could help India boost its energy security, support its farmers, and build a green economy. But to unlock its potential, India needs forward-thinking policies and investments in innovative technologies. The raw materials are there, the process works, the benefits are huge. All that's missing is the will and the way. But with the right moves, India could be producing billions of liters of green ethanol in the next decade. The energy future is bright, as long as we make the right choices today

An Introduction to Lignocellulosic Ethanol Production

Lignocellulosic ethanol is ethanol made from plant materials like agricultural waste, grasses, and wood. Unlike corn ethanol, it doesnot use food crops as feedstock. This advanced biofuel could help India meet its renewable fuel goals while boosting rural economies.

The production process involves breaking down the tough lignocellulose in plant materials into simple sugars, then fermenting those sugars into ethanol. First, the feedstock is pretreated to open up the lignocellulose structure. Enzymes and microbes are then added to convert the cellulose and hemicellulose into glucose and other sugars. Yeast ferments the sugars into ethanol, which is purified and concentrated.

The future looks bright for lignocellulosic ethanol in India. There are opportunities to boost rural economies by using agricultural residues and dedicated energy crops as feedstock. Advancements in pretreatment, enzymes, and fermentation technologies are making the process more cost-competitive. Policy incentives and investments in infrastructure will also help drive commercialization.

With abundant agricultural waste and a need for advanced biofuels, India is poised to become a world leader in lignocellulosic ethanol. With the right technologies and policies in place, this homegrown and sustainable fuel could power India as transportation sector in the years to come. The road ahead is challenging but promising. India's potential for lignocellulosic ethanol is enormous if fully realized.

The Availability of Lignocellulosic Biomass in India

India has an abundance of lignocellulosic biomass that can be used to produce ethanol. Agriculture residues like wheat straw, rice straw, and bagasse from sugarcane are plentiful. Forestry residues such as wood chips, sawdust, and logging residues are also widely available.

These lignocellulosic materials are largely unused and underutilized. They are often burned or left to decompose, contributing to air pollution and greenhouse gas emissions. Using them to produce ethanol instead could help mitigate these issues while creating a new source of biofuel.

The amount of lignocellulosic biomass generated each year in India would be enough to produce over 30 billion liters of ethanol annually. That more than enough to meet the government goal of 20% ethanol blending with gasoline. The key now is continuing to improve the technology and processes to make lignocellulosic ethanol production cost-competitive with ethanol from molasses and corn.

India has several advantages for developing an advanced biofuels industry based on lignocellulosic feedstocks. It has a large amount of agricultural and forestry land, a tropical climate with abundant rainfall, and a large population providing both agricultural and technical labor. The government is also actively supporting biofuels through policies, incentives, and funding for research and development.

With continued progress, lignocellulosic ethanol can play an important role in India energy security, environmental sustainability, and rural economic development. The resources and motivation are there; now the promise of this technology must be unlocked through ingenuity, investment, and persistence.

The future of renewable biofuels in India is bright, and lignocellulosic ethanol can shine the light.

Overcoming the Challenges of Converting Biomass to Ethanol

To unlock the potential of lignocellulosic ethanol in India, several challenges must be addressed. The process of converting biomass like agricultural waste into ethanol is complex and requires overcoming technological and economic hurdles.

Cost of Production

Currently, the cost to produce ethanol from lignocellulosic biomass remains high due to the expensive enzymes needed to break down the plant materials and the energy inputs required. For the technology to be viable in India, continued research to lower production costs through improved enzymes, more efficient processes, and use of cheap, abundant feedstocks will be key.

Feedstock Availability

India has a variety of agricultural residues like rice and wheat straw that could serve as feedstocks, but a steady, reliable supply of biomass must be ensured. Setting up collection systems and storage facilities will be important to provide a consistent source of raw materials for ethanol production. Additional feedstocks like bamboo, and cultivation of energy crops can also help supplement agricultural waste.

Commercialization Challenges

While several pilot and demonstration lignocellulosic ethanol plants have been built in India, the technology has yet to be deployed commercially. Private companies may be hesitant to invest in full-scale facilities due to economic uncertainties. Policy incentives, public-private partnerships, and government funding for first-of-a-kind plants can help mitigate risks and spur commercialization of the technology, which will drive further innovation and cost reductions.

Overcoming these barriers will require coordinated efforts across research institutions, private companies, farmers, and policymakers. With continued progress, lignocellulosic ethanol can provide India with a sustainable biofuel that reduces emissions, boosts energy security, and generates income opportunities for farmers and rural communities. But achieving an economically viable and scalable industry will depend on advancing the technology, securing stable feedstock supply chains, and promoting commercialization through policy and public support.

Emerging Technologies Making Lignocellulosic Ethanol Cost-Competitive

Emerging technologies are helping make lignocellulosic ethanol cost-competitive with corn-based ethanol. Several innovative processes are improving the efficiency and economics of converting plant materials into biofuels.

Consolidated bioprocessing

Consolidated bioprocessing (CBP) combines cellulase production, cellulose hydrolysis, and fermentation into a single step. CBP eliminates the need for expensive cellulase enzymes and reduces processing time. Genetically engineered yeasts and bacteria can simultaneously break down cellulose into sugars and ferment those sugars into ethanol. CBP is a promising approach to lowering costs, but more research is needed to develop microorganisms that can efficiently carry out both cellulolysis and fermentation.

Biomass pretreatment

Pretreating plant materials helps make the cellulose more accessible to enzymes and microbes. Leading pretreatment technologies include steam explosion, ammonia fiber expansion (AFEX), and dilute acid pretreatment. These processes open up the lignocellulosic structure so cellulase enzymes can easily access the cellulose. More effective pretreatment will enable faster, more complete conversion of biomass into biofuels.

Enzyme engineering

Advances in biotechnology are enhancing the ability of cellulase enzymes and microorganisms to deconstruct plant materials. Scientists are engineering more efficient enzymes and enzyme cocktails tailored to specific feedstocks. Directed evolution and rational design are being used to improve enzyme activity, stability, and cost. Customized enzymes will reduce the amount needed and lower overall process costs.

The development of advanced technologies is key to unlocking the potential of lignocellulosic biofuels in India. Continued innovation in fields like CBP, pretreatment, and enzyme engineering can help make ethanol from plant waste cost-competitive, providing economic and environmental benefits for India transportation sector. With abundant agricultural residues and a growing need for sustainable energy and fuels, India is well-positioned to benefit from emerging bioconversion technologies.

The Future of Lignocellulosic Ethanol in India: Policy Support Needed

India has set an ethanol blending target of 20% by 2030, but to achieve this, lignocellulosic ethanol must play a bigger role. Conventional ethanol from molasses and grains alone will not suffice. For lignocellulosic ethanol to take off in India, several policy measures are needed

Incentivize Cellulosic Ethanol Production

The government should provide incentives for companies to invest in cellulosic ethanol plants. Tax rebates, subsidies, and loan guarantees for commercial-scale biorefineries can help reduce risks. Creating a market for cellulosic ethanol by mandating its blending at higher percentages will also drive demand.

Support Feedstock Development

India needs to invest in developing feedstocks suited to its climate, especially perennial grasses like switchgrass and miscanthus. The government should fund research on high-yielding, drought-tolerant crops that require little fertilizer. It can also offer incentives to farmers to grow these energy crops.

Invest in Infrastructure

Transporting bulky biomass requires good infrastructure. The government must improve road and rail networks connecting farms to biorefineries. It should also fund the construction of preprocessing hubs to densify and pelletize biomass for easier transport

Strengthen R&D

Continued research is key to improving conversion technologies, developing better enzymes and yeasts, and unlocking the full potential of agricultural residues and waste. The government should increase funding for R&D and partner with private companies and research institutions.

To become a leader in cellulosic ethanol, India needs forward-looking policies that create a favorable environment for investment and innovation. With abundant biomass, a fast-growing economy, and a vibrant agricultural sector, India has all the right conditions to make lignocellulosic ethanol a key part of its biofuel strategy. Strong government support can help make that vision a reality.

Conclusion

So there you have it, the immense promise of lignocellulosic ethanol production and what it could mean for India energy and economic future. While the technology still needs to cross some hurdles to reach commercial viability, the rewards of unlocking this potential are huge. India has no shortage of agricultural and forestry residues that could serve as feedstock to produce ethanol at scale. Successful implementation of this technology could help India meet its ambitious renewable energy targets, reduce pollution and greenhouse gas emissions, increase energy security by reducing oil imports, and boost rural economies. The road ahead is long but the destination is in sight. With continued research, policy support and private investment, lignocellulosic ethanol could soon power India into a greener future. The future is bright, so keep your eyes on the horizon!

BECPL TEAM AT UPDA INTERNATIONAL SUMMIT 2.0, LUCKNOW ON 28TH AND 29TH JULY 2023

FACTORS THAT AFFECT BIOETHANOL PRODUCTION & NUTRIENT BIOAVAILABILITY

RAGHAVENDRA SHARAN SINGH

Sales & Technical Manager
(Alcohol Industry)

STRESSES:-

During industrial bioethanol production, yeast experiences several environmental stresses that have a significant impact on ethanol production. Mitigation of these stresses through nutrition reduces the variability of yields in fermentation.

The main types of stress are enlisted below.

Physical stress:-

This is non-optimal physical conditions that influence yeast growth. For example, the optimal **temperature** for Saccharomyces cerevisiae yeast is 30°C, but industrial ethanol production temperatures often exceed 33°C, while the hydrolysis stage requires higher temperatures. With the increase in the temperature, ethanol toxicity to yeast increases. Other physical stressors include osmotic stress due to the high concentration of various molecules – including sugars, and hydrostatic pressure due to the height of the fermentation vessel.

Chemical stress:-

Chemical stress are suboptimal composition of the medium. The most important chemical stress is a wrong pH. pH can be too acidic because of the inorganic acids used in the hydrolysis stage or because of the organic acids accumulated by the metabolism of bacterial and fungi contaminants. Additionally, feedstock usually contains inhibitory compounds such as chelating factors that remove metals necessary for yeast metabolism, bacterial and mycotoxins (see Nutrition factors section). Chemical inhibitory factors in the final stages of fermentation also include ethanol, which in high concentration inhibits yeast growth.

Biological stress:-

Biological stress is caused by the competition with other organisms – mainly bacteria. Because the feedstock is not sterile, resident microorganisms compete with the yeast for the substrate and produce substances inhibiting yeast growth.

Another source of biological stress in yeast population ageing. Yeast cells can produce daughter cells a limited number of times. After reaching the maximum division number, yeast cells enter into senescence with a low metabolic rate and then die. Physical and chemical stresses, including limited amounts of nutrients, speed up population ageing, while optimal nutrition mitigates them.

BIOAVAILABILITY:-

Nutrient bioavailability is the rate and extent to which the active nutrient is absorbed from the medium and used by yeasts in their metabolism. chemical analysis, or testing, of the feedstock will not inform about the bioavailability of nutrients. that is because each of the nutrients may be in a form that yeasts are unable to utilize. For example, the significant amount of essential nutrient nitrogen in beets juice is found in the form of betaine, a compound that yeast cannot access. Another factor that reduces bioavailability is metabolism inhibitors that are present in the feedstocks. testing the bioavailability of each critical nutrient by growing yeasts under controlled conditions on a particular feedstock and adding the nutrients separately. Often, the limiting factor can only be discovered after adding it significantly improves the ethanol output.

HOW TO POUR WINE

MAMTA BHARDWAJA

Business Development Manager
(Wine Industry)

If you have party at your place and you are serving wine for your guests and wine is dripping from the sides of the bottle, how you feel??? Very embarrassing!!! When you are a wine host, wine should be presented and poured correctly. It is one of the wine etiquettes. Pouring wine correctly is just a matter of practice.

First of all, use proper wine glasses for your wine. Make sure that glasses are clean without any spots. Also wine glasses should be free from any unwanted smell like detergent.

Place wine glasses on table. Take a bottle of wine, remove its foil and cork by using corkscrew. Offer a cork to your guests to examine it, if they willing so. Also while pouring, hold a bottle in your palm in such a way that the label should be facing the guest, so the guest can easily read the label for vintage, varietal and name of the wine.

The proper etiquette is, pouring for the women first, starting with the eldest woman at the table and filling clockwise.

The glasses should be poured approximately halfway, and then the bottle should be twisted when finished to avoid wine dripping on the table. Red and white wines should be poured into the center of the glass, while sparkling wines and champagne should be served into a tilted glass to keep the bubbles intact.

Wrap a napkin around the neck of bottle just for insulation. As you stop pouring twist the bottom of the bottle away from you to avoid dripping, and then go for next glass. That twist throws the last drop of wine back in to the bottle instead of dripping. But this requires practice.

For more detailed information in visual format you can always visit www.winesutra.in

Cheers!!!

HERBAL KOMBUCHA ➡ A FRUITY FITNESS DRINK

PRIYANSHI SHARMA

Sparkling wine

The easiest and most precise definition of wine is that wine is an alcoholic beverage made from fermented grape juice But when it comes to sparkling wine the term suggests that these wines have bubbles in it.

- Some popular sparkling wine :-
- Champagne (France)
- Creamant (France)
- Cava (Spain)
- Espumante (Portugal)
- Sekt (Germany)
- Franciacorta (Italy)
- Prosecco (Italy)
- Lambrusco (Italy)

Procedure to make sparkling wine

Sparkling wine might be the most technical of all wines in the world . The sparkling wine is so complex because of the need for two fermentations. One is to convert the grape juice into still wine which is called a base wine because still wines have no bubbles in it . Then another fermentation is done by adding yeast and sugar to the still wine as the yeast convert the sugar of still wine into alcohol and {Co2} bubbles.

Now , there are many methods and procedures to make sparkling wine but following are the two key methods in which a winemaker can achieve the desired fizz in a wine:-

1. Bottle fermentation

It is an intricate fermentation in which each bottle is used for fermentation and aageing. It normally requires More than 3 years .

The bottle fermented wines are more exorbitant as compared to the tank fermented wines . The texture of the bottle fermented wines are smoothy and creamy.

• Why it is called the traditional method in Europe?

It is called the traditional method in Europe as the most popular Champagne wine has been made by bottle fermentation for over 300 years and it cannot be made by any other process .

For ex – cava, Champagne, creamant, franciacorta and trento .

2. Tank fermentation

It is the most structured and expeditious method of fermentation. This fermentation is also known as charmat method as sparkling wine which are made with charmat method are normally low priced the reason behind is that the wines are made in the bulk or in more quantity in tanks and in a short period of time they are ready for harvest . The tank fermented wines are richer stronger and fruitier in flavours .

For ex – Prosecco , lambrusco and Asti.

• **Health benefits of drinking sparkling wine**

Wine is a normal alcoholic drink like any other drink. If it is consumed in an adequate amount then one can observe numerous benefits in health :-

• Improves our gut health and digestion.
• Boost our energy , mood , and cognitive function.
• Prevents from cardiovascular diseases.
• Also used for skin care .
• Sparkling rose wines also prevents hair loss
• Regulates the level of blood sugar .

Food combinations that one can try with sparkling wine

• One can try apple,pear , peaches and apricot with sparkling dry wine.
• Popcorn is considered to be a great snack with sweet sparkling wine.
• Champagne wine with veggies and stuffed mushrooms.
• Cava wine is a fantastic choice with potato chips and almonds.

Prosecco wine tastes well with sushi and Asian food .

Source – glass of bubbly.com , unravelingwine .com

LABORATORY ACCREDITATION-ENSURING "QUALITY AND RELIABILITY'

DR. JYOTI VOHRA JOHAR

Msc (Microbiology) PhD

Laboratory accreditation is the formal recognition by an accreditation body that a laboratory is competent to carry out specific tests or calibrations. Accreditation provides assurance to customers that the laboratory has been independently evaluated and has demonstrated its competence in accordance with international standards.

Here are some reasons why laboratory accreditation is important:

1. Quality assurance: Accreditation provides assurance that a laboratory is competent to carry out specific tests or calibrations. This ensures that customers receive accurate and reliable results, which are essential for making critical decisions.

2. International recognition: Accreditation is recognized internationally, which means that customers can have confidence in the results regardless of where the tests were carried out. This is particularly important for businesses that operate in multiple countries or export their products to different markets.

3. Compliance with standards: Accreditation requires laboratories to comply with international standards, such as ISO/IEC 17025. This ensures that laboratories operate to a consistent and recognized standard, which facilitates comparison of results between laboratories.

4. Continuous improvement: Accreditation requires laboratories to participate in proficiency testing programs and undergo regular assessments. This promotes continuous improvement and ensures that laboratories stay up-to-date with the latest developments in testing and calibration.

5. Competitive advantage: Accreditation provides a competitive advantage for laboratories by demonstrating their competence and commitment to quality. This can help to attract new customers and retain existing ones.

In India, laboratories can obtain accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL). NABL is an autonomous body under the aegis of the Department of Science and Technology, Government of India, and is recognized by the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

To obtain NABL accreditation testing/calibration laboratories must meet the requirements of ISO/IEC 17025:2017 standard for testing and calibration laboratories. This standard specifies the general requirements for the competence, impartiality, and consistent operation of laboratories.

NABL accreditation is recognized by regulatory bodies such as the Central Drugs Standard Control Organization (CDSCO) and the National Accreditation Board for Hospitals & Healthcare Providers (NABH), and is also accepted by several international organizations.

Laboratory accreditation can also be seen as a challenge as it requires significant investment of time and resources and changes to laboratory operations and procedures for compliance. Though challenging, but it ultimately is a boon for both laboratories and their customers as it promotes quality and reliability in laboratory testing.

WINE REPORT

KANCHAN SINGH

Chapter Head - South Delhi, India
Apex Wine Club India
1 June 2023, Thursday

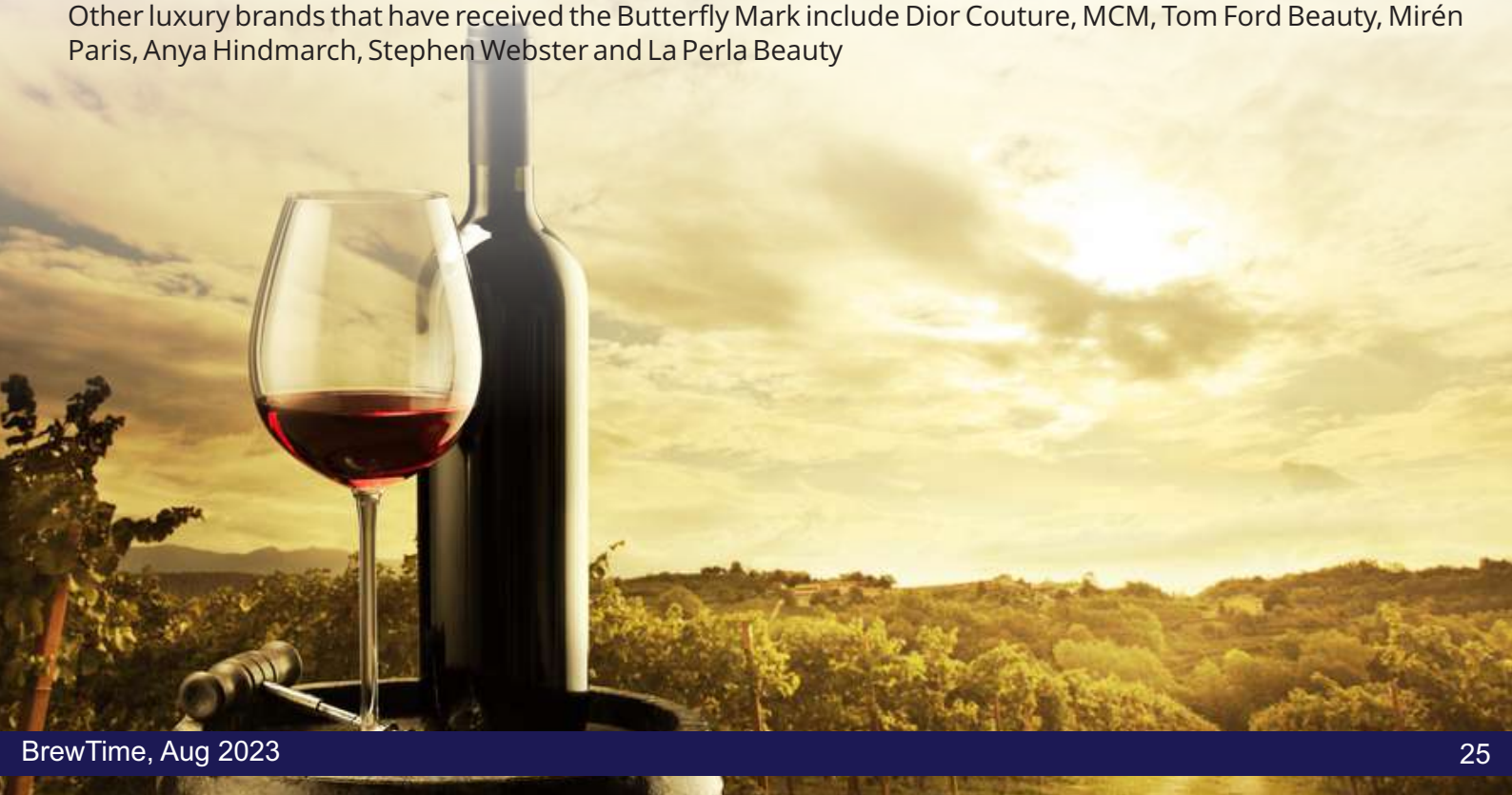
Chêne Bleu in the Ventoux region of France has received the Butterfly Mark for its commitment to sustainable practices.

The Butterfly Mark is awarded to brands and businesses which have a commitment to sustainability in all areas of operations, and follows an evaluation process, which covers the three principles of Environment, Social and Governance (ESG).

According to Positive Luxury, the organisation behind the Butterfly Mark, the score of Chêne Bleu is 20 per cent above the certification standard.

Other drinks brands with the certification are Aspen Distillers, Belvedere Vodka, Canned Wine Co, Clase Azul Mexico, Courvoisier, Eight Lands, Matusalem Rum, Suave Tequila, The Folclore Company, The Glenturret, The Macallan and West Cork Distillers.

Other luxury brands that have received the Butterfly Mark include Dior Couture, MCM, Tom Ford Beauty, Mirén Paris, Anya Hindmarch, Stephen Webster and La Perla Beauty



BALAJI ENZYME & CHEMICAL PVT LTD

Akshay Mittal Industrial Estate
A-113, 1st Floor, Building No 5, Sir M V Road, Andheri (East),
Mumbai - 400059 | +91-22-460 31 666
E-mail : info@becpl.in | Web. : www.becpl.in