SORGHUM BEER BREWING

Brewing Technology
BEER FERMENTATION TECHNOLOGY

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Also known as ‘kaffir beer”

Is an alcoholic beverage arising from the action of yeast on the saccharified mash of cereal malt

Consumed in a state of fermentation with active yeast cells being present
TRADITIONAL BEER

- Is opaque with suspended solids
- Colour - pink brown
- Odour - touch of fruitiness
- Taste - sour with after bitterness
- More viscous than barley beer
Sorghum or finger millet are used for malt
Enzymes include diastatic and debranching enzymes
Maize or cassava may be used as starch adjuncts
TRADITIONAL BEER

- Sprouted corn is ground to flour
- Water is added and boiling is done until a thick porridge consistency
- Poured in a cask and add lukewarm water until required quantity and thickness
- Sound corn flour is then added, mixed and allowed to stand for 24 hours

By the time of fermentation beer is strained and is fit for use.
COMMERCIAL PREPARATION

- Sorghum is the important malt grain
- Suits African climate- resistant to drought and heat

**Malting**
- Controlled germination leading to enzyme formation
- Alters grain structure and components so that enzyme breakdown is facilitated
MALTING PROCESS

- Grain is soaked in water for 1-3 days depending on weather
- Steeped grain is spread as a layer and allowed to germinate for 2-6 days
- Germinated grain is dried in the sun or indoors (kilning)
- When properly malted sorghum has 2-3cm growth of shoots and roots
- Germination leads to synthesis of α and β amylase- diastatic activity
Sorghum, maize, millets and rice have low diastatic activity than cereals of temperate climate such as barley, wheat and rye.

Also 18-50 % of amylolytic activity of sorghum is attributable to β- amylase, whereas in barley the β- amylase is the predominant starch degrading enzyme.
Diastatic activity depends on temperature of malting, moisture level, duration of malting process and percentage of germinated grains.

For optimum development of enzymes, sorghum requires malting at high temperatures of 25°C to 30°C.

Malting at below 17°C results in poorer malts.
Maltase, an insoluble enzyme present in unmalted grain, is not increased during malting.

- Protease activity increases 10 fold for exo and endopeptides.
**Kilning**

- Flavor development
- High temperatures will burn green shoots
- Low moistures protects from microbial attack
- Process controlled to give malts of varying sugars and color development
- Also it is important to maintain/ preserve sugars and hydrolytic enzymes as it is the main purpose for malting
Mashing

Production of wort or sugary liquid, used for fermentation

Cereal adjuncts normally used are usually are maize grits, whole maize meal degemermed sorghum, sorghum meal
Adjuncts are added cooked or uncooked
Added to malt and temperature adjusted
After mash is cooked, mash is strained and mashing temperature to remove coarse materials
**Souring** (at least 1 day)
During souring thermophilic bacteria multiply and produce LA
To sour pure culture is used or inoculation from a portion from previous souring.

Brought about by mesophilic and thermophilic bacteria

Thermophilic micro are homofermentative and function at high temperatures discourage growth of undesirable mesophiles.

Pediococci and Bacilli also produce LA with off flavours.

Spontaneous growth of these microorganism is ousted in industry.
At end of souring pH will be 3.0-3.3
LA produces sharp and refreshing taste to beer.
Well soured product is well received due to the taste
LA may also be used in cooking adjuncts to soften endosperm and increase the rate of gelatinization
Souring differs from brewer to brewer but a certain level of LA should be achieved
Method

- Mashed malt is inoculated with *Lactobacillus* culture and held at 50°C at a time to bring pH to 3.3

OR

- Mash is converted at neutral pH and cooled to 50°C, mash is inoculated with LAB culture and held until pH drops to 3.8-4.0

- In traditional brewing there was no inoculation of *Lactobacillus* practiced thus souring depended on bacterial population remaining on brewing vessels from previous brew
- Sugars and free aa produced are essential for the growth of lactobacilli
- At end of souring the mash is heated, water and more malt and cereal adjuncts may be added
- Coarser materials are removed
- Wort is ready for fermentation
**ALCOHOLIC FERMENTATION**

- Fermenting yeast is *Saccharomyces cerevisiae*.
- *Done for 2-5 days*
- At end of fermentation the product still contains a considerable amount of gelatinized and ungelatinized starch.
- Gelatinized starch helps to keep ungelatinized starch in suspension and contributes to creaminess and body of beer.
Figure 3.3 Traditional production of African sour opaque beer
Lager Beer

- Obtained by yeast fermentation of malted grain to which hops and water have been added

**Beer types**

- **Lager** - yeast settles to the bottom resulting in clear beer
- **Pilsner** - use hard water with higher Ca and Mg content than water used for lager
- **Ale** - yeast floats to the top resulting in cloudier beer - higher alcohol content
- **Stout/Porter ale** - very dark ale from roasted barley/malt
1. Barley malt

✓ Base malt- makes up provide most of enzymatic power to convert starch to sugars
- have the highest extract potential
- dark malts caramelized malts, roasted malts unmalted barley are added to give dark colours and enhance flavour.
Light Specialty malts - kilned at higher temps than base malts and impart a deeper colour and fuller malt flavour and aroma to finished beer.

Dark Specialty malts – have little or no enzyme activity due to high temperatures at kilning- have strong flavour and colouring components

Caramel malts – made from green malt

Roasted malts

Unmalted barley
Hops

- Hops are the dried flowers of the female hop plants.
- The cone contains the lupulin gland which holds the hop character, while the rest of the leaf material is used in a traditional brewery as a natural filter bed to retain the hot trub in a hop back.
- The aroma, flavor, and bittering properties derive from the lupulin glands containing the hop oil and resins in the hop flower.
- **Hop oil** contributes to the beautiful and intoxicating beer hop aroma and flavor, and alpha acid resins contribute to the hop bitterness of your homebrew.
Hops are added as sources of pyrogallol and catechol tannins, resins and essential oils for several purposes:

- provides the beer with a bitter taste;
- gives the characteristic hop aroma to the beer;
- promotes head formation and retention;
- promotes shelf life (antiseptic action);
- aids protein precipitation during the boiling of wort;
- acts as a filter medium in the hop back.
The bitterness potential of hops is derived from the $\alpha$-resins.

Alpha-resins consist principally of 3 $\alpha$-acids: humulone, cohumulone, and adhumulone.

The $\alpha$-acids require to be chemically changed or “isomerised” before they can be extracted and give their bitter tastes.

This occurs normally during the wort boiling.
3. **Brewers Yeast**

- S. cerevicea (top fermenting), S.uvarum (bottom fermenting)

- **Lager beers**: Bottom-fermented beers are generally called lagers. Historically, such beers were brewed to be stored (Germ. Verb. Lagern) for later use, but up to day this significance no longer exicts. Tradionally, bottom fermentations take place at 8 – 12 °C and the yeast, *Saccharomyces carlsbergensis*, collects at the bottom of the fermented beer.
Top-fermented beer: Most top-fermented beers are called ales in UK.

The term “ales” causes some considerable confusion and was used to describe all beer styles in England up until the 15th century (brewed without hops).

Top fermentations take place at 15 – 25°C, and the yeast, *S. cerevisiae*, rises to the surface where it is recovered by skimming.
INGREDIENTS: WATER

4. Water: 95% beer volume
   ✓ Contributes to beer flavor
   ✓ Depends on its mineral content, pH,

5. Beer adjuncts
   ✓ Unmalted grain added to brew kettle or mashtun
   ✓ Hardness influences reactions
Some reactions that can be influenced are:
- Enzyme activity during mashing;
- Hop extraction;
- The precipitation of proteins and tannins;
- The growth and metabolism of yeast.
Brewers can use adjuncts for different reasons:
- unmalted cereals usually are cheaper than malt;
- to impart desirable qualities to their products;
- to increase the density of the wort;
- to stimulate a second yeast fermentation.

The following adjuncts generally are used:
- Maize (corn) flakes (defatted);
- Rice grits;
- Wheat, malted or unmalted;
- Sugar-syrups, high-maltose syrups with low levels of nonfermentable carbohydrates.
BREWING PROCESS

A. Malt milling

✓ Expose starch and filtration of wort
✓ Type of milling is brewer specific
✓ Quality and uniformity of mash

B. Mashing

✓ Converting starch from milled malt and solid adjuncts into fermentable and unfermentable sugars to produce wort
Involves mixing milled malt and solid adjuncts with water at set temperatures

Conducted over a period of time to activate enzymes responsible for acidulation of mash and reduction in proteins and carbs.

Protein rest (proteinase and peptidases)- reduces high mwt proteins to low mwt proteins in mash.

Starch conversion (β and α amylase). α amylase splits starch molecules for use by β amylase
Factors affecting mash conditions

- Temperature
- Mash time
- Mash pH
- Malt modification
- Water ions
- Quantity of water
- Mash thickness
c. Wort Separation

✓ Also known as lautering
✓ Produce clear wort,
✓ Obtain good extract recovery
✓ Operate within acceptable cycle time

Equipment used
Mash Tun

✓ Combined conversion and wort separation vessel
✓ Produce wort from well modified malt
Lauter Tun

✓ Includes a sparging system to wash extract from mash
✓ Conical fitted to vent to allow vapors into atmosphere with wire screen at bottom acting as filtering system

Mash filters
Strain masters
D. **Wort Boiling**

- Stabilizing wort and extract desirable components from hops
- Sterilization
- Destruction of enzymes
- Protein pptn
- Color development
- Isomerization
- Dissipation of volatile constituents
- Concentration and oxidation
Wort cooling- in preparation for fermentation
Formation of cold break- coagulum precipitates and precipitation is best at 0-5 degrees reduces need for clarification
Aeration of chilled wort- provide yeast with sufficient oxygen for yeast growth during fermentation
E. Beer fermentation
✓ Carbs are converted by yeast into alcohol, carbon dioxide and other byproducts
✓ 2 types of yeast used traditionally
✓ S.cerevisiae and S.uvarum

F. Beer conditioning
✓ Reduces undesirable compounds to produce finished product
✓ Maturation, clarification and chill proofing
Maturation- lagering, bottle conditioning, casking and accelerated lagering

Lagering- secondary fermentation of fermentable extract at reduced rate controlled by low temp and low yeast count

Carbon dioxide further carbonates the beer

Low temperatures aid in precipitating haze forming materials
Beer bottling conditioning
Secondary fermentation and clarification in bottle induced by adding yeast and sugar to the beer
Or by removing primary fermentation yeast and repitch with ale or lager yeast
Beer Casking
Used to make pale ales porters and stouts
Beer is racked directly from fermenting vessels when fermentation is complete or when correct charge of yeast is present
Traditional beer lagering
Long cold storage for 1-3 months but in modern times 2-3 weeks at higher temperatures
Longer lagering time requires another clarification step
Lagering – reduces fermentation by products by reducing their solubility and encouraging precipitation of yeast and other haze loading materials

Centrifugation - reduces solid contents in beers and takes place for lagering and fining

Chill proofing - silica gels tannic acid etc used to improve beers physical stability

Filtration - reduces haze loads - poder filters are used eg perlite
Beer carbonation- contributing to fullness and enhancing foaming potential
Acts as flavor enhancer and extends shelflife of the product
Bottling and pasteurization

Flash pasteurization - used as continuous treatment of bulk beer prior to filling the bottles, cans, or kegs. Carried out on a plate heat exchanger.

Tunnel pasteurization - used for in-pack treatments following crowning of the bottles.
Success!!