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# EXPERIMENTAL STUDIES IN BREWING STEP DURING PRODUCTION OF BEER

**MANJIRI JOSHI* and MADAN PARANDE**

Department of Chemical Engineering, Bharti Vidyapeeth Deemed University College of Engineering, PUNE – 411043 (M.S.) INDIA

## ABSTRACT

Barley plays an important role during the production of beer. All kinds of barley are not suitable for melting step and production of beer. The barley as a raw material must be free from disease and almost free from debris and damaged corns. Based on the encouraging laboratory data scale up studies were carried out on semi commercial unit and the results presented the data, showed that the quality of beer was of high quality.

**Key words**: Barley, Brewing step, Beer.

## INTRODUCTION

Barley is the main raw material and is regarded as backbone of beer. It provides fermentable sugar to get alcohol during fermentation step[1]. It also provides dextrin that give beer mouth feel proteins, which are responsible for beer foam, malty flavor and aromas that balance hop bitterness in the final beer. Hops are one of the essential flavoring ingredients of most of the beers produced. The main flavor contributed by hop is a bitter flavor and to get bettering effect hops are added to the wort at the beginning of boiling. Hops also contain essential oils, which have a strong aroma and special aroma. Hops may be added to wort near the end of wort boiling so that essential oils do not distill off.

All kinds of barley are not suitable for malting and making beer. Barley that can be malted has well defined properties. The barley must be viable, free of disease, infection and reasonably free from debris and damaged corns. The grain should be of low nitrogen content, possess vigorous germination, potential for rigid and complete modification and ability to yield high level of enzymes.

*Author for correspondence; E-mail: manjirimjoshi@gmail.com

The following are key steps from barley to beer production.

## Malting

**(a) Steeping:** During steeping, the barley grains are imbibed or soaked with water. The first flush of water removes surface dirt and other impurities. After this operations the grain are soaked until they absorb 45% of water. The water is changed every 6-8 hours over a period between 24 to 48 hours depending upon the climatic condition. The steeping step therefore needs lot of water. Air is also essential during steeping because the grains are living and breathing organisms, which require oxygen for energy and excrete $CO_2$ while making that energy[2].

## Chemistry involved in steeping

During steeping, the barley starts to produce enzymes and process of production of enzymes is completed during germination[3]. The enzyme degrades starches into simple sugar, which can be utilized by growing grains. The energy to produce these can be represented by equation –

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Heat}$$

In order to effectively control the malting process, it is important to maintain uniform supply of oxygen, get rid of $CO_2$, make sure that temperature does not rise too high.

## Germination

The barley grains are allowed to germinate, producing new barley plant. This process produces enzymes[4], which are needed to convert starch into sugars and break down some of hard, insoluble parts of Barley. The germination process needs constant supply of air and water. The fully germinated barley is known as “Green Malt”.

## Brewing

Brewing operation consists of following steps[5] viz,

**(a) Milling:** Typically a six roller mill is used comprising of three sets of rollers set at different apertures with sieves, which selects fractions for next set of rollers. The malt after the milling is called “Malt Grist”.

**(b) Mashing:** During the mashing, the starches in grist are converted to sugars. The grist is mixed with high quality of heated water (65$^o$C). The mash is continuously mixed by

using appropriate agitator and under controlled heating. By this operation virtually all the starch is converted into sugars. The solution of the soluble materials in water is called "Wort".

**(c) Boiling:** The wort is now boiled vigorously in a "kettle" for about an hour. Hops are added at different stages of boiling operation. The main purpose of boiling is,

- To sterilize the wort
- To precipitate out undesirable proteins, tannins and carbohydrates.
- To concentrate wort
- To get flavors.
- To get rid of some undesirable flavors like Dimethyl-sulphide (DMS).

Hops are essentially flavoring ingredients for most of the beers. The main flavor contributed by Hops is a bitter flavor.

### Fermentation

Yeasts are viable living cells[3,6,7], which are pitched into the wort and utilize the fermentable wort sugars to produce alcohol and $CO_2$ for their respiration or energy requirement[2]. The wort is food for yeast cells which multiply during fermentation. At the end of fermentation process, there are about 5-8 times more as yeast at the beginning, which can be used for the next fermentation. Fermentation is followed by Beer filtration, cooling and packaging.

## EXPERIMENTAL

### Experimental work done during brewing step

Six batches are carried out for brewing process on semi-commercial unit. Since European market has entered in India, and they are stringent about dimethylsulphide content, colour and coagulable nitrogen. The analysis is carried out by taking into consideration the above parameters as those are responsible for the quality of wort.

Measurement of nitrogen is carried out by using rapid distillation unit supplied by M/s Labcones Corporation-Kansas City USA, Colour is determined by using Neo Colour Comparator supplied by M/s Labcones Corporation-Kansas City USA.

## RESULTS AND DISCUSSION

Since the sample was not drawn in a homogenous condition, the values at the start of boiling are high, however proper sampling precautions were taken in subsequent brew batches.

**Table 1: Brew batches 1, 2 and 3**

| Raw material | Additives | Hops |
|---|---|---|
| Malt-3050 Kg | $CaCl_2$ (2 Kg) | |
| Rice-640 Kg | $CaSO_4$ (4 Kg) | 9.5 KG |
| Sugar-600 Kg | Lactic acid (4 Litres) | |

**Table 2(a): Analysis of wort (Batch 1)**

| S. No. | Parameters | Start of boiling | End of boiling | Middle of wort cooling |
|---|---|---|---|---|
| 1 | Dimethyl sulfide (μg/L) | 395.0 | 60.0 | 76.0 |
| 2 | Coagulable nitrogen (mg/L) | 245.0 | 12.0 | 27.0 |
| 3 | Colour (EBC units) | 12.10 | 10.30 | 9.70 |
| 4 | Thiobarbituric acid (TBZ) | 15.75 | 29.45 | 33.60. |
| 5 | polyphenols (mg/L) | 151.0 | 172.0 | 162.0 |

**Table 2 (b): Analysis of wort (Batch 2 and 3)**

| S. No. | Parameters | Start of boiling | End of boiling | Middle of wortcooling |
|---|---|---|---|---|
| 1 | Dimethyl sulfide (μg/L) | 210.0 | 36.0 | 70.0 |
| 2 | Coagulable nitrogen (mg/L) | 58.0 | 38.50 | 20.0 |
| 3 | Colour (EBC units) | 7.40 | 9.90 | 10.07 |
| 4 | Thiobarbituric acid (TBZ) | 17.0 | 30.0 | 35.0 |
| 5 | polyphenols (mg/L) | 102.0 | 123.0 | 117.0 |

**Table 3: Brew Batches 4, 5 and 6**

| Raw material | Additives | Hops |
|---|---|---|
| Malt-2990 Kg | $CaCl_2$ (3 Kg) | |
| Rice-1450 Kg | $CaSO_4$ (4 Kg) | 20 Kg |
| Sugar-600 Kg | Lactic acid (4 Litres) | |

**Table 4: Analysis of wort (Batch 4)**

| S. No. | Parameters | Start of boiling | End of boiling | Middle of wort cooling |
|---|---|---|---|---|
| 1 | Dimethyl sulfide (μg/L) | 105.0 | 34.0 | 62.0 |
| 2 | Coagulable nitrogen (mg/L) | 54.10 | 18.60 | 19.0 |
| 3 | Colour (EBC units) | 5.80 | 6.40 | 9.17 |
| 4 | Thiobarbituric acid (TBZ) | 18.0 | 31.0 | 38.0 |
| 5 | polyphenols (mg/L) | 141.0 | 171.0 | 162.0 |

**Table 5: Analysis of wort (Batch 5)**

| S. No. | Parameters | Start of boiling | End of boiling | Middle of wort cooling |
|---|---|---|---|---|
| 1 | Dimethyl sulfide (μg/L) | 80.0 | 22.0 | 28.0 |
| 2 | Coagulable nitrogen (mg/L) | 40.80 | 19.83 | 14.0 |
| 3 | Colour (EBC units) | 6.42 | 8.28 | 9.14 |
| 4 | Thiobarbituric acid (TBZ) | 18.0 | 29.70 | 35.0 |
| 5 | polyphenols (mg/L) | 143.6 | 175.0 | 140.0 |

**Table 6: Analysis of wort (Batch 6)**

| S. No. | Parameters | Start of boiling | End of boiling | Middle of wort cooling |
|---|---|---|---|---|
| 1 | Dimethyl sulfide (μg/L) | 130.0 | 20.0 | 34.0 |
| 2 | Coagulable nitrogen (mg/L) | 44.33 | 22.10 | 17.50 |
| 3 | Colour (EBC units) | 5.80 | 7.80 | 8.90 |
| 4 | Thiobarbituric acid (TBZ) | 17.50 | 29.20 | 34.10 |
| 5 | polyphenols (mg/L) | 147.0 | 165.0 | 146.0 |

## CONCLUSION

(i). All the values of wort are in normal range, hence the quality of wort is satisfactory.

(ii). The content of dimethylsulphide is within the threshold value, and therefore the beer and wort produced are of high quality[5].

(iii). The values of thiobarbuturic acid contents are close to the optimum values[5].

(iv). Although, the values of colour and nitrogen vary from batch to batch, but are within optimum range[5].

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