# Physiochemical Properties of Beer Produced From Malt Barley

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***Abstract:*** **Beer is the world's oldest and most widely consumed alcoholic drink; it is the third most popular drink, after water and tea. After fermentation process, the beer was subjected to filtration and analyzed by various techniques such as, water analysis including test for chlorides, alkalinity and for hardness. Beer analysis also includes calcium test, alcohol test for five days and the absorbance values for iron test and Diacetyl test for beer by using UV-Vis spectrophotometer. The properties of beer were found to be as: pH 4.09, Spectrum color 7.65, Haze 0.60 Nephlometric Turbidity Unit, Apparent extract 2.1˚P, Calcium test with 47 ppm, the Iron test with absorbance at 505nm were noted as 0.178 and Diacetyl test with absorbance at 203nm was found 0.154.**

***Index terms: UV-Spectroscopy, Fermentation, Haze, Diacetyl.***

## I. INTRODUCTION

Beer is the world's widely consumed alcoholic drink; evidence indicate that beer has also been a popular drink in many ancient cultures. According to established documents, numerous types of beer and beer-like beverages from different grains were industrially manufactured in some ancient countries such as Egypt, Rome, China, India, and Iran[16]. Most beers produced worldwide have alcohol content in the range of 3–6% (v/v)[17,3]. The production involves the fermentation of sugars, mainly derived from cereal grain starch, most commonly from malted barley, although wheat, maize (corn) and rice are widely used. Fermentation is a metabolic process that converts sugar to acids, gases, or alcohol. It occurs in yeast and bacteria, and also in oxygen-starved muscle cells, as in the case of lactic acid fermentation. Beer is produced by brewing. Brewing is the process of producing beer from cereal starch. The purpose of brewing is to convert the starch source into a sugary liquid called wort and to convert the wort into the alcoholic beverage known as beer through a fermentation process effected by yeast. The raw materials used for the production of beer are malt barley and broken rice. Malt is the broken form of barley. It is the major source in production of beer. Broken rice is used as an adjunct along with malt barley in the production of beer. Hops is a flavoring agent used in the production of beer. It gives bitterness to the beer. It acts as a natural preservative. The addition of hops to fermented beer in the presence of yeast may result in a secondary fermentation commonly referred to as “after-fermentation,” “dry-hop creep,” “Alcohol By Volume creep,” (ABV) and “the freshening power of the hop” (FPH)[9]. Hop derived volatiles and their transformation products strongly impact beer flavor. Extensive research has been performed to unravel the secrets of hop aroma by analyzing its chemical composition and by identifying the high impact odorants of hop essential oil.[1,4,7,11,12] Caramel is used as a sweetening and coloring agent in the production of beer. Hydroxyl radicals are reactive toward virtually all beer components, and are ultimately responsible for the generation of staling compounds[10]. Diacetyls are known to be important flavor compounds of fermented food, such us alcoholic beverages and dairy products, and to be produced by microorganisms during fermentation[14].

The major parameters of water like hardness, chlorides, alkalinity and the bitterness, color of the beer and some beer analysis like iron test, calcium test, diacetyl test and the apparent extract of beer are being examined in this study.

## II. MATERIALS AND METHODS

### Sample collection

The samples were collected from a Brewery industry located in Goa during 2017, 50 ml of sample was collected in a aseptic bottle and stored under 35℃ for further analysis. All chemicals used in the chemical tests were of analytical grade.

### Water analysis

### Determination of chlorides

A test was carried out to evaluate the quantitative determination of chloride ions. This test was carried out by titrating the solution of 100 ml water sample containing 1 ml potassium chromate with 1 ml 0.2 N silver nitrate solution;end point was yellow to brick red[6].

Chlorides = Burette reading x 35.45 (1)

(Range of chlorides should be below 50 ppm)

**Test for Alkalinity**

Alkalinity is the measure of hydroxide and carbonate ion content of water sample. The solution of 100 ml water sample with few drops of methyl orange is titrated with standard HCl using indicator[14].

Alkalinity = Burette reading x50 (2)

(Range of alkalinity should be below 100 ppm)

**Test for hardness**

Hardness of water samples were tested by titrating the solution of 100 ml water sample containing 1 ml of ammonia buffer and few drops of Eriochrome black with 0.02 N EDTA solution[6]; end point was violet to blue.

Hardness = Burette reading x 10 (3)

(Range of hardness should be 60 ppm)

**Alcohol test**

The alcohol test of the beer is carried out by taking 150 ml of beer which is shook for few minutes for formation of foam. The beer is degassed. The 100 ml of degassed beer is mixed with s50ml of distilled water. The distillation takes place in the distillation column. Alcohol is obtained as the distillate.

**Beer analysis**

**Bitterness of beer**

The bitterness of beer is tested by taking 10 ml of beer with 1 ml of 3N HCl and 20 ml of isooctane is added, then it is kept in wrist shaker for 15 minutes at 250 rpm, then the sample is placed in a UV-Vis spectrophotometer( Systronics, UV-Vis Double Beam Spectrophotometer 2201). The Absorbance wass measured at 275 nm[8].

**Color of Beer**

The color of beer is carried out by taking 10 ml of beer with 1 ml of 3N HCl and 20 ml of isooctane is added, then it is kept in wrist shaker for 15 minutes at 250 rpm, then the sample is placed in a UV-Vis spectrophotometer( Systronics, UV-Vis Double Beam Spectrophotometer 2201). The Absorbance was measured at 430 nm [5,2].

**Test for iron in beer**

The test for iron in the beer sample is carried out by taking 25 ml of beer with 1 ml of ascorbic acid and then 2 ml of 0.3% Orthophenethroline is added. Reverse shaking of the sample takes place for 2 to 3 times in the wrist shaker. The Sample is placed in a UV-Vis spectrophotometer (Systronics, UV-Vis Double Beam Spectrophotometer 2201), then the absorbance is measured at 505 nm.

**Test for calcium in beer**

The test for calcium in the beer sample is carried out by taking 20ml of beer with 10ml of distilled water and then 3 ml of 5N NaOH is added. Then 0.5 ml of calcein indicator is added to the sample. The sample is titrated against 0.005M EDTA. The endpoint was color changing from fluorogreen to golden yellow.

Calcium = Burette reading x10

(Range of calcium should be between 40 to 60 ppm) (4)

**Diacetyl test for beer**

The diacetyl test for beer was carried out by taking 100 ml beer with 3.5 ml disodium hydrogen phosphate. Then distillation takes place in the distillation column. Then 18.1 ml of the distillate is collected in test tube. The distillate is made up to the final volume of 20 ml. The 10 ml of the final volume with 1 ml hydroxylamine is taken in a test tube. The test tube is kept in oil bath until the sample gets reduced to 5 ml.Then1 ml of disodium hydrogen phosphate is added to the sample and made up to a final volume of 10 ml with distilled water. The absorbance is measured at 230 nm in a UV-Vis spectrophotometer( Systronics, UV-Vis Double Beam Spectrophotometer 2201).

**Test for turbidity and apparent extract of beer**

The beer sample is taken in a beaker. Turbidity of the beer is measured by placing the beer sample in the hazemeter[15]. The beer sample is degassed by transferring vigorously from to another beaker several times. The apparent extract of the beer is calculated by placing a hydrometer. The scale in the hydrometer and temperature are noted.

When temperature is above 20℃ for every rise in the scale, 0.05 should be added to the scale value and when the temperature is below 20℃ for every fall in scale, 0.05 should be subtracted from the scale value.When the temperature is 20℃,0.05 need not be added or decreased from the scale value.

## III. RESULTS AND DISCUSSION

**Water analysis**

**Test for chlorides and alkalinity of tap water and municipal water**

The test for the chlorides and alkalinity of the water samples was carried out and the readings were given below in Table 1.The readings given in the table are calculated by using equation (1) and (2).

**Table 1 (Test for Chloride and Alkalinity)**

| Chloride Test | | | | Alkalinity Test | | | |
|---|---|---|---|---|---|---|---|
| Tap Water | | Municipal Water | | Tap Water | | Municipal Water | |
| Burette Reading(ml) | ppm | Burette Reading(ml) | ppm | Burette Reading(ml) | ppm | Burette Reading(ml) | ppm |
| 0.55 | 19.49 | 0.35 | 12.4 | 1.2 | 60 | 0.9 | 45 |
| 0.4 | 14.18 | 0.5 | 17.72 | 1.8 | 90 | 1.0 | 50 |
| 0.45 | 15.95 | 0.35 | 12.40 | 0.9 | 45 | 1.0 | 50 |
| 0.6 | 21.27 | 0.55 | 19.49 | 0.95 | 33.67 | 1.2 | 60 |

The color change from pale orange to pink was observed due to the presence of calcium carbonate in the water . The tabulated ppm values in Table 1 for alkalinity was found to be in the range below 100 ppm.

The colour change from pale yellow to brick red was observed due to the presence of chloride ions in water. The tabulated ppm values in Table 1 for chlorides was found to be in a range of below 50 ppm.

**Test for hardness of tap water and municipal water**

The test for the hardness of the water samples was carried out and the values are given below in Table 2. The values given in the Table 2 was calculated by using equation (3).

**Table 2 (Test for hardness)**

| Hardness Test | | | |
|---|---|---|---|
| Tap Water | | Municipal Water | |
| Burette Reading(ml) | ppm | Burette Reading(ml) | Ppm |
| 3.8 | 38 | 4.12 | 41.2 |
| 2.8 | 28 | 4.7 | 47 |
| 4.3 | 43 | 5.2 | 52 |
| 4.0 | 40 | 4.8 | 40 |

The color change from violet to blue was observed due to the presence of magnesium ions in the water. The tabulated ppm values in Table 2 for hardness were found to be in the range below 60 ppm.

**Alcohol test**

In alcohol test, the degassed beer was distillated and the distillate was obtained from the distillation column in the form of alcohol.

*Figure1 ( The distillate was collected from the distillation unit in the form of alcohol)*

**Beer analysis**

**Test for color, haze and apparent extract of beer**

The color, haze and apparent extract of the beer from the unit tanks 2,3,4,5,6 is calculated and the values are given in the Table 3.

**Table 3 (Test for color, haze and apparent extract of beer)**

| Unit Tank | Haze (NTU) | Apparent Extract (˚P) | Temperature (°C) | Spectrum Color | pH |
|---|---|---|---|---|---|
| 2 | 0.41 | 1.7 | 15 | 6.24 | 4.07 |
| 3 | 0.58 | 1.7 | 14 | 5.95 | 4.14 |
| 4 | 0.54 | 1.7 | 14 | 5.49 | 4.04 |
| 5 | 0.49 | 1.9 | 12 | 6.55 | 3.93 |
| 6 | 0.60 | 2.1 | 14 | 7.65 | 4.09 |

The tabulated values of haze in the Table 3 were found to be within the standard range of less than 0.7 NTU.

The tabulated values of Apparent extract in the Table 3 were found to be within the standard range of 1.8 to 2.2˚P.

The tabulated values of color in the Table 3 were found to be within the standard range of 5 to 8.

The tabulated values of pH in the Table 3 were found to be within the standard range of 4 to 4.4

**Iron test**

The iron test for beer was carried out by taking the absorbance of the beer sample in the spectrophotometer. The values are given below in Table 4

**Table 4 (Iron test)**

| Water | | Beer | |
|---|---|---|---|
| Absorbance (nm) | Concentration (ppm) | Absorbance (nm) | Concentration (ppm) |
| 0.046 | 0.3005 | 0.178 | 0.1420 |
| 0.005 | 0.0390 | 0.017 | 0.1151 |
| 0.080 | 0.5186 | 0.011 | 0.0755 |
| 0.013 | 0.0882 | 0.029 | 0.1944 |

The tabulated values of Iron test in the Table 4 for beer were found to be within the standard range of less than 0.150 ppm

**Calcium test for beer**

The calcium test for beer was carried out for the beer by titration and the values were calculated by using equation (4) in the Table 5.

**Table 5(Calcium test for beer)**

| Unit tank | Burette reading (ml) | ppm |
|---|---|---|
| 2 | 4.2 | 42 |
| 3 | 5.35 | 53.5 |
| 4 | 4.57 | 45.7 |
| 5 | 4.7 | 47 |

The color change from fluorogreen to golden yellow was observed due to the presence of calcium in the beer sample. The tabulated ppm values for calcium test in the Table 5 were found to be in the range of 40 to 60 ppm.

**Diacetyl test**

The diacetyl test for the beer was carried out in the oil bath and the absorbance and concentration of the beer sample in the spectrophotometer.

**Table 6 (Diacetyl test for beer)**

| Unit tank | Absorbance (nm) | Concentration (ppm) |
|---|---|---|
| 2 | 0.072 | 0.023 |
| 3 | 0.154 | 0.049 |
| 4 | 0.062 | 0.017 |
| 5 | 0.126 | 0.025 |
| 6 | 0.146 | 0.034 |

The tabulated values of diacetyl test for beer in Table 6 were found to be within the standard range of less than 0.070 ppm.

## IV.CONCLUSION

The results obtained from the analysis of the water samples like tap water, municipal water and beer samples produced by malt barley from the different unit tanks during the study was compared to those of standard values and were found to be within the standard range.

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