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Research Article

Assessment of Different Quality Parameters in Graded Barley Malt (An Industrial approach)

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Abstract

The different quality parameters of 2 row barley malt graded into four grades based on screening was determined. The malt contained 57-72 and 38-49 per cent of endosperm and bran respectively. The moisture content was highest (5.19 percent) in the large sized grade and the lowest of (5.093 percent) in the lower grade from the sample collected from the silo of Barmalt Malting India ltd Gurgoan India. The HWE, filtration rate, color and turbidity range was 71.92-77.40 per cent, 10-12 minutes, 4-5.5 (lb) and 0.034-0.46 (abs) respectively in all the four categories. The average filtration rate was 172.26 ml/hr. The total nitrogen, soluble nitrogen, and Kolbach index was 1.57-1.73, 0.55-0.68 and 34.4-39.2 percent respectively and among the physical tests done like Thousand corn weight, Acrospires, Friability, Homogeneity, Partially unmodified grain and Glassy were seen to be in between 32.42-41.26, 34.72-70.23, 65.76-75.24, 87.65-93.20, 12.34-6.79, 9.3-1.7 per cent. All the tests revealed best quality in the size of greater than 2.8mm size of the malt.

Keywords: Malt, Thousand kernel weight (TCW), acrospires, wort and Hot Water Extraction (HWE)

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Introduction

Barley (*Hordeum vulgare, vulgare* L.) is a highly adaptable cereal Grain that is produced in climates ranging from sub-Arctic to subtropical. It ranks 5th among all crops in dry matter production in the world today (129 million metric tons, 2002 to 2005 mean) [1]. India's annual production of barley has been steadily around 1.2 to 1.5 million tons in the recent years with production in 2008-2009 estimated to be around 1.54 million tons. In India annual demand from beer and feed industry is estimated to be around 60,000 tons and 25000 tons respectively, however, rising demand for beer among India's urban young consumers is leading to increased demand for barley malt from Indian beer manufacturing units and the beer consumption was estimated to grow by 51% between 2006 and 2011. This time, only 2% of barley is processed for human food [2]. Barley is the primary cereal used in the production of malt in the world. Two types of barley are mostly used for the malting process: 6 and 2-row. Two-row barley gives malt with a large extract, lighter color, and low enzyme content than the 6-row type [3]. From the different quality parameters reported in the literature, hot-water extract (HWE), β-glucan, kernel size fractions, kernel weight and protein contents, malting losses, friability, viscosity, α-amylase activity, and soluble nitrogen ratio (SNR) are common tests used to test the quality of barley mutant [4]. During malting, barley undergoes an incomplete natural germination process that involves a series of enzyme degradations of barley kernel endosperm. As a result of this enzyme degradation, endosperm cell walls are soften, and starch granules are released from the matrix of the endosperm in which they are embedded. These structural changes inside and biochemical degradations of the endosperm components are referred to as endosperm modification [5]. Three process steps are necessary to ensure that these changes occur, Steeping, to ensure good absorption of water by the grain (from 12% to at least 40% of moisture), Germination, to maintain embryo growths enzyme synthesis and a limited endosperm breakdown, and Kilning, to ensure product stability. The present study was to conduct and evaluate the total yield of different parameters that are necessary in the generation of wort from different grades of barley malt.

Materials and Methods

The Samples (malted barley) were collected randomly from different slots of the malt warehouse, (Barmalt India LTD, Gurgoan), mixed them & thus giving a bulk sample. Some of sample was marked as control sample. The remaining sample was cleaned manually and by sieving to remove impurities and dockages and then investigated for quality in the quality control lab of Barmalt Malting India Pvt Ltd Gurgoan India. The sample was divided into three categories based on the size of the grain kernels using sieving machine. The sizes include; 0-2.5mm, 2.5-2.8mm greater than 2.8 mm and Control sample. The size of the grains greater than 2.8mm is used by the company after different quality parameters are checked. The similar procedures were followed for all kinds of grain size categories. Grades, kernel plumpness were determined with methods from CGC's Official Grain Grading Guide and 1000 kernel weigh. Other barley and malt analyses were performed according to the standard methods of the American Society of Brewing Chemists (ASBC) & EBC 1997 methods. Malt analyses included;

(1) Malt extract (fine grind), a measurement of the amount of malt that can be extracted into the solution, thus, indicating a malt's degrading factors and malt barley beer production potential;

(2) Soluble protein, which is required for adequate foam stability in beer, although, too much soluble protein can result in beer hazes and darker colored beers.

(3) Viscosity and friability, all indicators of the extent to which the barley endosperm has broken down during malting and

(4) Wort color, an indication of final beer color, was determined with methods from CGC's Official Grain Grading Guide.

Result and Discussions

The moisture content of barley malt is one of the characteristics, particularly in relation to safe storage**.** The malt moisture content difference was not significant among the varieties. The malt moisture content for long shelf stable storage is recommended 4 to 5% [6]. Kilning apparatus (conventional air draught oven) influences moisture removal from the green malt. Inadequate moisture removal on kilning might have resulted in malt moisture content to be slightly greater than 4.8%.but the system was so controlled that it showed the moisture content as recommended.

The Hot water extract in case of particle size greater than 2.8 mm was found more as compared to the particle size of less than it and that is the reason it is being used in the companies. With an increase in the proteins, there is reduction in the starch level in the kernel and a reduction in the HWE is the likely result [7].Most companies prefer the HWE values of up to or more than 75 percent. From the above results the particle size of 0-2.5mm and of 2.5-2.8 presented the values of less than it. If both the grain sizes are mixed together, they could give the values of the HWE corresponding to the company norms. The reason for high values of the extract in big size particles is due to the presence of high content of starch turned into simple sugars and also into water soluble components.

The values of turbidity were seen to be more in the order of 0-2.5mm >2.5-2.8>2.8mm. the particle size 0-2.5mm were seen to be too hazy because of the presence of chaff and outer hull which is rich in anthocyanins gives it more color and also due to the presence of dust particles and other colloidal forms due to which it was not seen to be clear with the naked eyes, while the other three samples were find to be more clear. After that, the result depicted from the UV spectrophotometer became quite authentic. Different maltesters, mostly prefer clear wort for further processing to beer or for the brewery purposes.

The color was also carried by using UV spectrophotometer and the results were again higher for the smaller size particles as below in **Table 1**.

Table 1 showing the color of the four particle size when studied under UV spectrophotometer

Parameter	**0-2.5mm**	**2.5-2.8mm**	**>2.8mm**	**Control sample**
Colour [Abs]	0.068	0.043	0.038	0.044

However if the particle size of 0-2.5mm and 2.5-2.8 is to be used for efficient processing (to form a clear wort) they must undergo the screening step, which helps them to remove the dust, dirt and other foreign substances responsible for providing the more turbid nature of the wort. In all the five samples, the reading came to be more perfect matching HWE. More the size of the grain more is the presence of soluble constituents and intern yield more during mashing. pH has a great impact during further processing, when wort is used to make a beer. During the fermentation step, less the ph, less will be the alcohol generated and will impact the quality of beer processing.

The values were more proportionate to hot water extract. In all the five samples, filtration rate came to be more in particle size from, 2.8mm, 2.5-2.8mm and then 0-2.5mm. All the three values in all the five samples taken were matching with the average values of the control samples. This signifies the true values of filtration rate. The greater the filtration rate per hour means less is the viscosity and more is the saving time according to the economic stand point of view because the company would take less time to process the wort after the filtration step. One more thing if the filtration rate is slow that means more is the turbid or hazy mixture. The values in the grain size of less than 0-2.5mm and 2.5-2.8mm were showing low values of filtration rate due to the clogging of pores in the whatman filter paper grade 1, during filtration [8]. Specific gravities vary from company to company. Different companies prefer specific gravity of the wort of more than 1.03. The values in the five samples showed more than that. But in the samples of the particle size 0-2.5mm was found less as compared to the other three particle sizes. Greater the specific gravity of the sample means more is the density of the constituents [9] and hence more will be the ease of fermentation for the yeast, as it provides a dense medium for the growth. Viscosity has a great impact on the flow behavior of the wort. Although the specific gravity has also an effect role on the viscosity yet the reading was found to be less as believed. For a company to use particle size of 0-2.5mm and 2.5-2.8mm the wort should be cooled more to find effective production in beer production. Greater the nitrogen content more is the hot water extract. For an effective hot water extract more nitrogen should be provided in the grain during the growing of the barley grain. The nitrogen values as well as HWE were found to be coinciding with each other which show the result to be perfect enough.

Soluble nitrogen in samples varies from one to other. Since nitrogen in the form of protein is used as a substrate by yeast [10]. So it becomes compulsory that the soluble nitrogen be present in the correct order as mentioned in the standards of European barley convention. The values of the low grades where showing low results. In order to increase its amount in the wort for an effective beer quality, the grain should be grown in a high nitrogen medium. Kolbach Index is basically the ratio between soluble nitrogen and total nitrogen. This has a great impact on the extract values. Again as stated, the values could automatically be lower in the lower sizes of the grain.

Table 2 Results of the Quantitative analysis of different quality parameters according to ASBC and EBC

Parameters	0 -2.5mm	2.5-2.8mm	>2.8mm	Control sample
Moisture	5.19±0.64	5.058±0.45	5.093±0.40	4.736±0.45
Hot water extract [%]	71.92±1.03	75.9±0.58	77.4±0.69	75.9±0.59
Saccharification time [min]	11-12	11-12	10-11	10-11
Turbidity [Abs]	0.046±0.22	0.042±0.20	0.034±0.17	0.038±0.18
Colour [lb]	5-5.5	4.5-5	4-4.5	4-4.5
Ph	5.74±0.67	5.89±0.66	5.97±0.55	5.92±0.63
Filtration rate [ml/hr]	92±8.76	179.4±10.20	245.4±10.74	198.6±10.93
Specific gravity	1.031±0.06	1.032±0.04	1.033±0.043	1.032±0.037
Viscosity	1.44±0.43	1.50±0.5	1.59±0.60	1.55±0.65
Total nitrogen [%]	1.57±0.34	1.64±0.55	1.73±0.61	1.623±0.43
Soluble nitrogen [%]	0.55±0.55	0.621±0.69	0.685±0.69	0.632±0.68
Kolbach index	34.4±4.40	37.2±5.16	39.2±4.49	37.6±5.1
Thousand corn weight [%]	32.42±3.83	35.12±1.8	41.26±4.19	36.16±2.20
Acrospires [%]	34.72±5.79	49.14±5.39	70.23±4.42	61.33±2.8
Friability [%]	65.76±5.24	70.66±4.94	75.24±4.56	72.56±4.47
Homogeneity [%]	87.65±4.56	88.96±4.46	93.20±4.04	91.58±3.69
Partially unmodified grain [%]	12.34±4.56	11.04±4.46	6.79±4.04	8.41±3.69
Glassy [%]	9.3±4.5	6.3±3.9	1.7±2.29	3.4±2.51

Conclusion

The study found the four malting grades, as graded, gave a significant indication of final malting quality. The top grade (greater than 2.8mm size), showed the best quality. However, inconsistent storage conditions and source of samples, especially the special select samples, reduced the significance of correlations between grade and malt quality. A repeat of the study with greater attention to consistent supply and testing of samples would help conclusion on the value of the results in predicting malt quality. The potential increase in objectivity of the testing, among the six row barley, needs to be further investigated and depict the difference in results between the six row and two row barley malt. Supporting additional testing is needed to verify this promising aspect of predicting end use quality of malting barley.

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