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Impact of Malt Barley Varieties on Malt Quality: A Review

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ABSTRACT

The greatest use of barley for malting purpose mostly for brewing industry. The quality of malt depends upon various grain parameters as kernel shape, size, boldness, grain protein content *etc*., which affects the malt quality that is malt yield, friability, homogeneity. The availability of barley for malting is not a problem, but whatever barley is available it is very poor interims of quality and not meeting the minimum standards of malting quality. So, that identification of malt barely varieties with different grain and malt parameters, which are desired for better malt production and quality improvement, needed for various products is very essential. Potential areas that boost the production, pertinent agronomic practice studies and strengthening micro malting laboratory and expert capacity are recommended to overcome the limitations of malt barley production and malt quality improvement.

Key words: Malt barley, Malt quality.

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Background of the review

Barley (*Hordeum vulgare* L.) is one of the most ancient crops among cereals and has played a significant role in the development of agriculture in the world (Alnarp, 2013). It is one of the most important, economically valuable and widely used cereal crops, which belongs to the family Poaceae with a diploid chromosomes number (2n=14) (Alnarp, 2013). There is comprehensible verification that barley originated from the Eastern Mediterranean in an area called the Fertile Crescent, which is covering geographic areas now in Israel, Jordan, Lebanon, Syria, southeastern Turkey, Northern Iraq and western Iran. However, Ethiopia is also considered as center of barley diversity with a high level of morphological variation between landraces that resulted from adaptation to diverse climatic conditions and soil types the country (Selamawit and Tariku, 2018).

Global barley production is estimated about 141.7 million tons (USDA, 2017). Globally European Union, Russia, Canada, USA and Argentina are the top five largest world barley producers where, European Union produces the greatest quantities of barley with an estimated production of 20.5 million tons followed by Russian federations with a production of about 8 million tons, whereas Canada, USA and Argentina barley production was estimated 7.3, 3.1 and 2.8 million tons respectively (USDA, 2017). Ethiopia is the second largest producer of barley in Africa next to Morocco, accounting for about 26 per cent of the total barley production in the country (Shahidur *et al*., 2015). It is the fifth important cereal crop next to tef, maize, sorghum and wheat in the country's domestic production with total area coverage of 959,273.36 hectares and total annual production of about 2.03 million tons in main season, whereas the mean barley productivity was 2.1 tons ha^{-1} (CSA, 2017). In Ethiopia, barley production is highly concentrated in Oromia National Regional State with total area coverage of 454,662.78 hectares and total annual production of about 1.09 million tons, whereas the mean barley productivity was around 2.4 tons ha^{-1} in main cropping season (CSA, 2017).

The greatest use of barley for malting purpose mostly for brewing industry. The increased competition within the brewing industry needs maximizing the raw materials. Barley is the basic raw material for brewing. Its chemical composition is highly affected the beer quality and the economic efficiency of the brewing process. A large number of parameters have been important to define malting quality. The texture of endosperm influences the malt modification process by affecting water uptake and enzyme synthesis within the endosperm (Biadge and Yadesa, 2017). The malting process has a very large impact on the resultant malt quality. It is evident that both variety and the malting process have a large bearing on these key malting parameters with different samples of the same malting variety following substantially different paths to final malt quality. It is likely that malthouse processing parameters and environmental conditions including prevailing temperature and humidity have a large effect on malt quality. It is a credit to the maltster that malthouse conditions are manipulated to minimize variation and optimize final malt quality. Once completed, this investigation aims to understand the interaction between malthouse conditions, variety and barley samples to enable maltsters to more knowledgably select varieties and malting conditions to better meet the expectations of customers for parameters such as the level of attenuation (Yousif and Evans, 2015).

In Ethiopia, barely is a dependable source of food in the highlands areas. Its grain is used for the preparation of

different foodstuffs, such as *injera, kolo* and local drinks, such as *tela, borde* and beer (Melle *et al*., 2015). Biadge and Yadesa, (2017) reported that the malting of hull less barley presents a number of challenges due to difference in chemical and physical change. The structural changes and biochemical degradation of the endosperm components referred to as endosperm modification. Therefore, different modification of kernel properties have been identified as a factor affecting water uptake during stepping of barley, protein, starch granule size and distribution of enzymes are factors affecting the hardness of the endosperm. Therefore, reviewing and gathering information based on the previous research finding, as well as identifying the knowledge and research gaps under the impact of malt barley varieties on malt quality is very important. The target is to clarify the appropriate varieties for malting and brewing industry. This provides a good suggestion for the assortment of the most excellent varieties and supplementary improvement.

Objective of the review

To review the impact of malt barley varieties on malt quality.

Review of Literature

Definition of terms

Malt barley varieties

Malt barley varieties are bred specifically for characteristics that promotegood malting and brewing performance, such as high enzymatic activity, as well as good agronomic performance and disease resistance. Each malting barley variety behaves differed during the malting process for this reason it is important to segregate varieties when they are grown, stored, shipped and processed. Using and a high quality, certified can help to ensure varietal purity. Varieties of barely do not to be mixed together at the time of malting.

Impact of malt barley varieties on grain and malt quality characteristics

Grain size and germination

Biadge and Yadesa, (2017) was conducted a field experiment in ten different varieties of malt barley and was determine the grain size as well as germination. The highest mean grain size percentage was recorded for the varieties Holker (96.5%), Bekoji 1 (96.5%), Bahati (97.5%), Beka (97.5%), Miscal 2 (66.5%) and HB 1307 (95.5%). Varieties with high grain size indicate in equivalence in size. The lowest value was recorded for varieties HB 1533 (88.5%), Ibon174/03 (93.5%) and Traveller (91.5%). On the other hand, germinative are the two tests used for assessing the barley grain dormancy. Germinative ability is the determination of the percentage of living corns with in a sample of barley, while Germinative energy is the determination of the percentage of grains which can be expected to germinate fully if sample is malted normally at the time of the test. Germination energy might be reduced if barley encounters excessive levels of moisture during germination, a phenomenon called water sensitivity. The water sensitivity of barley is indicated by the 8 ml germination eneregy, which is obtained by adding additional 4ml water a total of 8 ml to the 4 ml germination test. The mechanisms involved in water sensitivity remain unknown, although microbes are thought to be involved. Moreover, germination energy of the minimum of 95% germination on a 3 day germination test is an absolute requirement. All the varieties were no problem for germination test. All varieties had above 95 germination energy. The germination energy is the total number of grains that germinate over 72 h of incubation under specified conditions (Biadge and Yadesa, 2017).

Moisture and Protein content

The moisture content of varieties varied between 3.6 to 6.9%. Miscal 21 (9.6%), Holker (6.7%), Bekoji1 (6.1%) and sabini (6.9%) were with high moisture content. Moisture levels need to be low enough to prevent heat damage and the growth of disease microorganisms. The rest of the varieties were within the accepted range of malt moisture content. The malt moisture content for long shelf stable storage is recommended 4 to 5% (Biadge and Yadesa, 2017). Further more; malt moisture content that ranges 6.4 to 7.1% was found. Kilning apparatus 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 at this moisture level the malt can be stored as shelf stable for reasonable duration since moisture 6.4 to7.1% is still regarded low to invite pest infestations. Among the varieties of Beka is different from the rest.

The malt protein had ranged between 6.4 to 7.4%. A reduction in protein content has been found in all varieties when compared to the protein level in the grain 8 to 10% and this protein level is suitable for pale ale and lager type malts (9 to 10% proteins).This has happened because on malting large molecules like proteins and carbohydrates will be broken down into simpler molecules that are utilized by the developing shoots and roots. The reduction of protein is a normal phenomenon in malting.The protein content, soluble protein content of the malt result showed that there was significance difference among varieties. Lowest mean protein content were obtained in Holker (9.6%), followed by Traveller (10.1%). Miscal 21 (13.5%), Beka (12.5%) and Ibon 174/03 (12.1%) protein content which were very high and indicates low extract yield. The rest of the varieties were in the range 9.6 to 11% protein content which were in the accepted range. Desirable protein content range for 2 rowed barley is 9.0 11.0% and for 6 rowed barley is 9.0 upto 11.5%. Soluble protein for the varieties was ranged from 3.9 to 7.7% which showed that good amino acids sources for yeast growth. Amino acids and peptides they are important nitrogen sources for yeast growth. Varieties which had high Kolbech index Were Travller (42.9), Grace (39.1), EH-18-47 (39.6) and HB-1307 (39.2) which indicates high protein modification that gives the degree of solubility of barley protein during malt production should be between 39-44% (Biadge and Yadesa, 2017).

Significant difference occurred between HB 52 and Holker, HB120 and Beka, Holker and Beka and HB 52 and Beka. This indicated difference among the varieties in terms of the rate at which modification took place on malting. The thousand kernel weight of the unmalted barley grain was ranged 32.5 to 46.4 g. A reduction in the thousand kernel weight that had ranged 3.4 to 6.1 g was obtained after malting and the reduction was high among the varieties with high thousand kernel weight (that is, HB 52 followed by HB 120). The loss associated to malting increases with germination time and temperature. An increase in malting loss in sorghum with increasing germination time from 2 to 6 days and temperature from 18 to 25°C. On malting a weight loss of 10.0 to 20.0% is anticipated for the industrially prepared desirable barley malt and the weight loss (10.5 to 13.0%) for the varieties are in this range.Similarely, Protein content is one of the important parameters in selecting malting barley. It is affected by genotype, cultural practices and growing environments. Malt barley with high protein content results in lower extracts. It also slows down water uptake during steeping, potentially affecting final malt quality. A very low protein level, on the other hand, results in a lack of enzymes necessary to modify the barley kernel and to break down the starch during brewing. Low protein also impairs the brewing performance due to poor yeast amino acid nutrition.

Thousand kernel weight results showed that there was significance difference among the varieties. Varieties Bekoji 1 (40.0), Ibon 174/03 (42.8), Holker (36.7) were high in grain size. Thousand grain weight (g) should be >45 g for 2 rowed barley and > 42 g for 6 rowed barley.These results for most varieties were low according to the standard requirement for malting industry (Biadge and Yadesa, 2017). Smaller grain generally has lower starch and higher protein levels, thus reducing the extract potential. Large grains generally have increased levels of starch and therefore more extract potential.

There were significant differences among varieties for friability content.Varieties with high friability was Grace (90.2), Sabini (86.5), Holker (74.9), Bahati (67.5) and Traveller (63.1) which indicates high lautering performance. Varieties with low friability were Miscal 21 (31.6), Beka (38.5) HB 1533 (33.7) indicated that under modification can lead to poor mash conversion and more high viscosity polysaccharides such as beta glucan. Factors that interfere with endosperm modification, such as poor germination, large kernels and high protein, are expected to reduce malt friability (Biadge and Yadesa, 2017). The friability meter is a device whose role is to physically disintegrate the grain of malt and to separate its friable constituents from the hard constituents. More a malt is friable, better will it be disintegrated. The whole grain percentage permits to examine the homogeneity of the share. The friability meter allows simplifying the analysis of malt while giving the degree of accessibility to enzymes.

Malt extract content and PH

The fine grind, coarse grind extract and extract difference of the malt result showed that there were no significance difference among varieties.Varieties with high malt extract were Holker (80.9), Travller (80.5), Beka (78.9), Sabini (78.5) where as varieties with low malt extract were Miscal-21 (73.8), EH 18 upto 47 (75.5) and HB 1533 (76.8). Extract difference were poor for most of the varieties which indicates low malt modification. The extract yield reflects the extent of enzymatic degradation and the solubility of grain components after malting and mashing. Mean EBC hot water extract value ranged from 75.0 to 80.7% but this result were indicated most of the varieties in the specification of the EBC standard. The study result indicates high malt extract result compared to EBC range for the varieties (Biadge andYadesa, 2017).

The hot water extract of wort, commonly called as malt extract is the most important trait whether selecting potential new malting varieties or trading malt. Malt extract may be the most complex malting quality trait in terms of biochemistry and genetics. It is a comparable trait to grain yield in that they are both mega-traits influenced by a number of sub-traits. The major part of the extract produced in mashing consists of fermentable sugars, which constitute 61-65% of the total extract. The quality of malt is influenced by several factors. The first factor is environmental, such as growing conditions, temperature, fertilizer, available nitrogen, or moisture. These factors do not impact on extract directly but rather affect traits that influence extract, particularly protein and starch levels and composition. The second factor includes several genetic biochemical components that influence the final level of extract. These include 2 or 6 row types, husk thickness, grain size, protein, starch, non starch polysaccharides and enzyme production. The third factor that influences extract is the malting process itself Apart from the malt extract, the color of wort was significantly different among the varieties. The mean color of wort among varieties ranged from (3.7 to 7.0 EBC unit) Varieties which were not in the EBC specification were Travller (5.0), Beka (5.5), Ibon174/03, HB-1533 (5.2) whereas the other varieties were in the specification range. Color variation in wort is due to non enzymatic browning reactions, the Maillard reaction, that take place during kilning in the malting process, and wort boiling in the brewing process. In this case, the sugars interact with the amino acids, producing a variety of odors and flavors. This reaction is the basis of the flavoring industry with the type of amino acid involved determining the resulting flavor and color. In this study most of the varieties were in the specification range according to brewing industry (Biadge and Yadesa, 2017). The pH range for the varieties was 5.56.5 which was in the specific range of European brewery convention. Varieties with appropriate pH were Bekoji 1 (5.6), grace (5.7), Sabini (5.9), Miscal 21 (5.9) and Holker (5.9). It was shown that over the pH range 5 to 6.6, the photolytic activity of malt can vary. pH variation limits the growth of microorganism in this case the growth

of fermenting yeast is influencing within the variation of pH. But the PH of wort is in the specified range (Biadge and Yadesa, 2017).

CONCLUSION

It is concluded that the quality of malt depends upon various grain parameters as kernel shape, size, boldness, grain protein content *etc*., which affects the malt parameters *i.e*. malt yield, friability, homogeneity. As discussed above the optimum range of these parameters is required for the malting process so that the higher recovery of malt with good quality parameters can be obtained.

Generally high quality malt barley variety has the following characteristics:

- Pure lot of an acceptable variety.
- Germination is 95% or above.
- Protein content ranging between 9.5% to 12.5% (dry basis).
- Moisture content below 13.5%.
- Plump and uniform kernels.
- Free of disease and other contaminated agents.
- Less than 5% peeled, broken and damaged kernels.
- Clean and free from any foreign material which is different from the original one.

RECOMMENDATION

It is recommended that the availability of barley for malting is not a problem, but whatever barley is available it is very poor interims of quality and not meeting the minimum standards of malting quality. So that identification of malt barely varieties with different grain and malt parameters, which are desired for better malt production and quality improvement, needed for various products. Potential areas that boost the production, pertinent agronomic practice studies and strengthening micro malting laboratory and expert capacity are recommended to overcome the limitations of malt barley production and malt quality improvement.

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