

Effect of Storage Time and Storage Temperature on the Quality of Malt Barley Variety

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Abstract: Barley storage is an important character for its processing and to maintain its ability to germinate rapidly that helps to keep or improve its quality. Two popular varieties (Holker and IBON174/03) under two storage material were used for the study. Storage time and Storage Temperature were used as a factor for quality of malt barley variety. Storage time up to one year can not affect the quality of malt barley varieties but the storage Temperature significantly affect the quality of malt barley varieties especially germination energy were improved up to 97% at the storage Temperature of twenty five (25°C) for both variety under two storage material.

Keywords: storage, malt barley quality, variety

1. INTRODUCTION

Barley storage is an integral part of technology of its processing on malt with desired quality. The aim of malting barley storage is to keep or even improve its quality (Mikyška and Prokeš, 2009). Barley grain must be stored such as to maintain its ability to germinate rapidly and uniformly and at the same time must be protected from moisture and pests. To ensure uniform quality of malting barley supplies for storage appears the usage of long-term (multi-annual) storage of qualitative batches of malting barley (Sychra et al., 2001). Prerequisite for successful storage of malt is to keep highly hygroscopic malt cool and dry to avoid excessive intake of water. If the moisture content remains below 4%, malt can be stored under appropriate conditions for several months (Kreisz, 2009; Kunze, 2014; MacLeod, 2004). Generally, malts have moisture content below 5% and such content is not very favorable for fibrous micromycetes or insect pests. The variability of malt components during its storage depends mainly on temperature and water activity. Both of these factors should be as low as to preserve high quality of malt (Basařová, 2015; Kunze, 2014). The aim of this experiment was to evaluate, how the quality of malting barley altered by long storage and Temperatures.

2. MATERIALS AND METHODS

Two varieties (Holker and Ibon174/03) of improved malt barley samples (grown in 2016/17) were obtained from Holeta Agricultural Research Center/Barley breeding program. Samples were cleaned and sorted manually. The cleaned malt barley varieties were subjected to different storage temperature and packing materials (Jute bag and plastic bag) for one year storage duration. The grains were stored at -10°C, 5°C and 25°C temperatures. The samples were stored with approximately 10-12 % moisture content. The malt quality hectoliter weight, thousand kernel weight, moisture content, crude protein, germination energy and grain size were analyzed after each four month up to one year.

3. MALT BARLEY QUALITY ANALYSIS

3.1. Hectoliter Weight

Hectoliter weight was determined on dockage free samples using a standard laboratory hectoliter weight apparatus (grain analysis computer (GAC) 2100) as described in the AACC (2000) method no 55-10.

3.2. Thousand Kernel Weights

Thousand kernel weights were determined by taking 1000 kernel barley samples counting and weighing then calculated as percentage corn weight.

3.3. Moisture Content

five gram of ground sample in a clean dry moisture crucible were placed in oven at 105 °c for three hour and the sample were allowed to cool in a desiccators to maintain the sample temperature to room temperature for 30 minute.

$$MC = \text{Weight before} - \text{Weight after} * 100 / \text{Total weight}$$

3.4. Germination Energy

Five hundred grains was distributed evenly on the whole surface of germination plate. The plate was moistening with distilled water. The germinated grain was removed after 48, 72 and 96 hour and counted.

$$\text{Germination energy}(\%) = 500 - n / 5, \text{ where } n \text{ is the number of germinated grain}$$

3.5. Total Protein of Barley –Kjeldhal Method

One gram ground sample of malt barley measured and transferred into completely dry kjeldhal flask. Ten gram of kjeldhal tablet was added to the sample inside the flask. Twenty milliliter of 98% concentrated sulphuric acid was mixed with the sample. The sample digestion was started by connecting the kjeldhal flasks with the digestion rock (2000 FoodALYT SBS). And the digestion was completed when the brown color of the sample was completely disappeared.

After the digested sample was cooled, 250 ml of distilled water and 70 ml of sodium hydroxide (32%) were added and distilled into 25ml of excess boric acid containing 0.5ml of screened indicator. The distillate was titrated with 0.1N hydrochloric acid to the red end point.

$$\text{Total nitrogen}(N\%) = T - B * 0.1401 / W,$$

W is weight of the sample taken for analysis

T is volume of HCl used for titration

B is blank used as control

$$\text{Crude protein (CP \%)} = N * 5.83$$

3.6. Sieving Test of Malt Barley

Hundred gram of the grain sample was placed at the top of the sieve (>2.8mm, >2.5mm, >2.2mm and <2.2mm sieve sizes) and the grain was sieved into four fractions within five minutes. The four fractions were weighted at each sieve sites.

4. RESULT AND DISCUSSION

Effect of Storage Time and Storage Temperature on Malt Barley Variety Quality

Table1. Effect of storage Temperature on quality of malt barley variety IBON 174/03 Variety stored with Jute bag

Variety(IBON 174/03)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
+5°C	66.23±0.63	44.96±0.28c	9.2±0.17 b	93.8±0.57 b	11.25±0.51	60.36±24.19b
-10°C	64.66±0.57	45.5±0.3 b	8.5±0.17 b	89.51±0.54b	10.97±0.01	94.46±0.11b
25°C	65.63±1.32	46.96±0.05a	9.53±0.63 a	94.66±1.15a	10.69±0.12	90.43±0.115a

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table2. Effect of storage Temperature on quality of malt barley Holker Variety stored with Jute bag

Variety(Holker)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
5°C	66.2±0.51	53.89±0.52a	9.26±0.23b	93.86±1.15a	11.22±0.005c	82.25±0.63a
-10°C	65.66±1,7	44.2±1.15c	10.4±0.23a	91.63±0.58b	11.09±0.05b	79.89±0.05b
25°C	65.0±0.40	52.16±0.57b	10.76±0.05a	93.33±1.27b	10.89±0.06a	80.73±0.46b

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table3. Effect of storage Temperature on quality of malt barley IBON 174/03 Variety stored with Plastic bag(Fertilizer bag)

Variety(IBON 174/03)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
+5°C	64.93±0.23b	46.96±0.57a	9.4±0.17b	92.76±0.63b	10.37±0.24a	89.2±0.57c
-10°C	65.83±0.63a	45.73±0.57b	9.93±0.28a	91.8±0.00b	9.8±0.05b	91.2±1.03b
25°C	66.06±0.28a	45.87±0.11	9.7±0.17b	95.06±1.15a	9.92±0.02b	94.16±0.63a

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table4. Effect of storage Temperature quality of malt barley Holker Variety stored with Plastic bag(Fertilizer bag)

Variety(Holker)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
+5°C	66.63±0.28	52.73±0.05	10.46±0.23	91.2±0.23a	11.3±0.17a	83.68±0.63a
-10°C	67±0.17	52.73±1.15	9.96±0.05	90.66±0.5b	11.2±0.06a	79.03±0.11b
25°C	66.76±0.05	51.33±1.15	10.23±0.11	97.06±0.11ab	10.69±0.09b	82.67±0.34a

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

The results of storage temperature are presented in Tables1-5. The result Grain moisture is the limiting factor and that barley should be stored in dry conditions with a maximum moisture content of 14% (Kreis, 2009). According to (Hrivna, 2006), its further increase may result in a number of biochemical reactions that significantly reduce the storage period. According to the above study the experiment were done with moisture content of 10-12% in order to keep the biochemical reactions that affect the storage time and Temperature.

Both varieties stored in two conditions at -10°C decrease the germination energy. This shows the malt quality affected. The germination energy declines when moisture content and temperature are low, the decline is very slow. The results of (Baxter et al., 1991) strongly indicate that barleys can be stored for extended periods in low oxygen atmospheres, without any deleterious effects, either on recovery from dormancy, germination performance, or malting quality. Both variety stored in two Conditions as 5 and 25°C the germination energy greater for samples stored at 25°C stored with in twelve month especially both variety stored under two conditions at 25°C improve the germination energy up to 97% .

A minimum of 95% germination on a 3day germination test is an absolute requirement and the Germination energy is the total number of grains that germinate over 72 h of incubation under specified conditions (Wootton et al., 2005). Similar study shows that samples stored at 12% moisture content and 25°C is the ideal storage temperature for the grain to improve the germination energy (Rainer.et.al., 2002).

Table5. Effect of storage time on quality of malt barley IBON 174/03 Variety stored with Jute bag

Variety (IBON 174/03)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
First Four month	66.0±0.87	45.83±1.10	9.13±0.75	92.23±2.63	11.05±0.46	77.1±26.6
Second	66±0.87	45.83±1.1	9.13±0.75	92.23±2.63	11.05±0.46	77.1±26.5

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Four month						
Third Four month	64.53±0.83	45.81±0.98	8.96±0.37	93.54±3.04	10.81±0.15	91.06±3.2

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table6. Effect of storage Time on quality of malt barley Holker Variety stored with Jute bag

Variety(Holker)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
First four month	66.16±0.75	50.1±5.6	10.26±0.75	92.36±0.97	11.07±0.18	81.16±1.35
Second Four month	66.16±0.75	50.1±5.69	10.26±0.75	92.36±0.97	11.07±0.18	81.16±1.35
Third Four month	64.6±1.00	50.13±4.0	9.96±0.87	94.1±5.56	11.07±0.13	80.5±0.88

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table7. Effect of storage Time on quality of malt barley IBON 174/03 Variety stored with Plastic bag(Fertilizer bag)

Variety(IBON 174/03)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
First four month	65.63±0.73	46.2±0.98	9.8±0.3	92.8±1.36	10.01±0.18	91.1±2.48
Second Four month	65.63±0.73	46.2±0.98	9.8±0.3	92.8±1.36	10.01±0.18	91.1±2.48
Third Four month	65.56±0.72	46.1±0.37	9.4±0.2	93.9±2.32	10.11±0.47	92.4±2.5

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

Table8. Effect of storage Temperature on quality of malt barley Holker Variety stored with Plastic bag (Fertilizer bag)

Variety(Holker)	Malt barley quality					
	HLW	TKW	MC	GE	CP	GS
First four month	66.9±0.17	52.76±0.6	10.3±0.3	92.63±3.3	11.09±0.40	81.76±2.32
Second Four month	66.9±0.17	52.76±0.6	10.3±0.3	92.63±3.3	11.09±0.40	81.76±2.32
Third Four month	66.6±0.26	51.46±1.3	10.6±0.15	93.76±4.02	11.01±0.81	81.13±1.93

HLW=Hectoliter weight, TKW=thousand kernel weight, MC=moisture content, GE=germination energy, CP=crude protein, GS=grainsize

The results of storage time are presented in Tables 5-8. The quality of malt barley was not significantly different at ($p < 0.05$) by storage time factor. The result showed that the quality remained unchanged stored under jute bag for one year. The effect of storage time for the two varieties IBON 174/03 and Holker stored under plastic bag the quality of the malt changed as well as the quality of malt barley was significantly different at $p < 0.05$ for the parameters, Thousand Kernel weight, Moisture content, Crude Protein, Grain size and Hectoliter weight.

The effect of storage time for both varieties stored under two conditions has no significant change on the grain quality of malt barley. Similar study conducted on storage time up to one year malt varieties improve their quality up to one year storage time (Gothard, 1984). Effect of storage temperature for the two varieties IBON 174/03 and Holker the quality of malt barley stored under jute bag and plastic bag there were significant differences at $P < 0.05$ for the parameters Thousand Kernel weight, Moisture content, Crude Protein, Grain size and Hectoliter weight. The quality of the malt barley variety changed.

5. CONCLUSION

In General The storage time UP to one year malt Barley samples stored under Jute bag and plastic bag(Fertilizer bag) the quality of malt barley remains unchanged or not significant different due to storage time factor but malt barley samples stored under two conditions at different Temperatures. There was a significant difference on the quality of malt barley the germination energy improved up to 97% due to difference in Temperature.

Twenty five (25 c⁰) is the ideal Temperature to improve the quality of malt barley variety stored under two conditions for one year storage.

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