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Evaluation of Improved malt barley (Hordeum Vulgare L.) varieties for agronomic Performance and malting quality in East Gojjam zone

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Abstract

The study was conducted in the Debre-Markos Agricultural Research Center and Sinane district over two consecutive years (2019 and 2020) to evaluate agronomic performance and malting quality. A randomized complete block design with three replications was used to evaluate fifteen malt barley varieties. The analysis of variance showed significant differences ($p < 0.001$) among the tested varieties across all traits, indicating variability at Debre Markos. Highly significant ($p < 0.001$) differences in days to heading, days to maturity, plant height, spike length, biomass yield, and grain yield were observed in Sinan district. The combined analysis of variance showed a highly significant difference at $P < 0.001$ for grain yield, plant height, spick length, biomass yield, days to heading, and grain filling period. IBON174/03 (2736.08 kg h-1), HB 1964 (2362.08 kg h-1), and M-21 (2301.28 kg h-1) varieties were the first three best-performing varieties. The analysis of variance for quality traits revealed that there is significant variation among the tested varieties for all traits. Varieties HB1964 (9.77%), IBON174/03(9.96%), and M-21(11.32%) scored the acceptable range of kernel protein content. IBON174/03, M-21, and HB1964 were relatively high-yielding and fulfilled the acceptable range of the standard set by the National Standard Authority for kernel protein content of malting barley. Therefore, the varieties IBON174/03, HB1964, and M-21 were the top-performing malt barley varieties, contributing superior adaptability, high grain yields, and acceptable kernel protein content for regional production. These varieties are recommended for adoption in the region to enhance production and address the lack of improved, locally adapted, and high-quality options.

INTRODUCTION

Barley (Hordeum vulgare L.) was first domesticated around 10,000 BC, making it one of the oldest and most resilient cultivated grains (Zohary et al., 2012). Its capacity to flourish in a variety of often challenging climates establishes it as a vital element of global food security (Newton et al., 2011; Giraldo et al., 2019). Aside from being a major food staple, barley is the leading grain used for malt production due to its advantageous starch-to-protein ratio (Heena and Rachana, 2021). Its specific physical characteristics—particularly the husk, which shields the embryo and assists with filtration during brewing—provide it a clear edge over other cereals like wheat. This industrial application has positioned barley as a high-value crop that attracts the interest of entrepreneurs, farmers, and researchers alike (Kumar et al., 2013).

Barley Production in Ethiopia

Ethiopia is known as a global hotspot for barley diversity, featuring unique germplasm with high disease resistance (Vavilov, 1951). The country's history with barley dates back around 5,000 years, with the Agew people being credited for its initial cultivation around 3,000 BC (Zemede, 1996). Barley is grown at a wide range of altitudes, from 1,800 to 3,400 meters, making Ethiopia the second-largest producer of barley in Africa, contributing about 25% of the continent's total production (FAO, 2014; Muluken, 2013). Within the nation, barley is the fifth most significant cereal, benefiting over 3.9 million smallholder farmers (CSA, 2020). In the East Gojjam Zone, barley holds the fourth position in importance, cultivated

Statement of the Problem

There is a significant gap between the supply and the industrial demand for malt barley in Ethiopia, despite its considerable potential. Currently, malt barley makes up only 10% of the country's total production. The brewing industry requires about 118,000 tons of malt each year, but local sources only provide 52,000 tons, which is less than half of the required amount (Addisu, 2018). This shortfall is especially noticeable in high-potential regions such as the East Gojjam Zone, where production specifically for malt remains minimal.

Key obstacles include the lack of improved varieties tailored to specific sites and insufficient high-quality seed supplies. Without identifying high-yielding varieties adapted to highland areas, the gap between supply and industrial demand will widen, hindering import substitution and economic progress for farmers. It is essential to evaluate and select adaptable, high-quality varieties to boost productivity and satisfy industrial requirements. For this reason, the current study was designed to assess agronomic performance and malting quality of malt barley varieties in the target area.

Materials and Methods

Description of the Study Area

The study was conducted during the main cropping seasons of 2019 and 2020 in two locations: the Debre-Markos Agricultural Research Center (on-station) and the Welekie site in the Sinan District (on-farm). Both sites are located in the East Gojjam Zone of the Amhara Regional State, Ethiopia. East Gojjam is a fertile agricultural area with elevations ranging from 800 to 4,200 meters above sea level. It experiences a unimodal rainfall pattern, receiving between 900 and 1,800 mm of rain each year, and the average temperatures vary between 7.5°C and 27°C. The local farming system is mainly characterized by low-input subsistence agriculture, stretching from the Blue Nile gorge up to the summit of Choke Mountain. Key crops grown in this region include cereals such as tef, wheat, barley, maize, and sorghum, as well as highland pulses like faba bean, field pea, lentil, and grass pea, alongside oilseeds and various horticultural plants.

Experimental Materials and Design

A total of fifteen (15) malt barley varieties were assessed for their yield and agronomic performance. The trials were structured in a Randomized Complete Block Design (RCBD) featuring three replications. Each experimental plot comprised 10 rows, each measuring 2.5 meters in length.

Table 1
Description of 15 malt barley varieties used for the study

1	Variety	Year of release	Maintainer	altitude	Rainfall(mm)
	Holker	**1979**	**HARC**	***2500–3000***	***500–800***
2	**Bekoji-1**	2010	kARC	*2300–2800*	*> 700*
3	**HB1963**	*2016*	HARC	*> 2300*	*500–700*
4	**Fatima**	2018	HARC		
5	**Bahati**	2011	KARC	*2300–2800*	*> 700*
6	**IBON 174/03**	2011	KARC	*2300–2800*	*> 700*
7	Fanaka	*2015*	HARC	*2000–2600*	*500–1000*
8	Henerik	2018	HARC	-	-
9	EH1847	2011	HARC	*2200–2800*	*> 500*
10	M-21	2006	HARC	1550–2850	500–800
11	Traveller	2013	HARC	*2000–2600*	*500–1000*
12	HB1964	*2016*	HARC	*> 2300*	*500–700*
13	Sabini	2011	KARC	*2300–2500*	*> 700*
14	Grace	2013	HARC	*2000–2400*	*500–1000*
15	Planet	-	-	-	-

KARC=Kulumsa Agricultural Research Center, HARC=Holeta Agricultural Research Center

Crop Management

Sowing was conducted in late June, utilizing a seed rate of 85 kg ha^{-1}. The application of fertilizers adhered to local recommendations: NPS was applied at a rate of 121 kg ha^{-1} during the planting phase, while Nitrogen (Urea) was administered

in a total quantity of 50 kg ha^{-1}, with one-third applied at planting and the remaining two-thirds applied during the tillering stage. Moreover, all other essential agronomic practices and field management activities deemed necessary for the successful establishment and growth of malt barley were meticulously followed

Data Collection and Analysis

Data were gathered both at the plot level and for individual plants.

Plot-based Measurements: The following parameters were recorded for each plot: days to heading, days to maturity, grain yield (kg/ha), thousand-grain weight (g), and total biomass yield (kg/ha).

Plant-based Measurements

The average values for plant height, panicle length, and kernels per spike were calculated based on five randomly selected plants from the central rows of each plot

Laboratory Quality Analysis

Essential grain quality parameters—including grain protein content, extract content, friability, and β-glucan content—were quantified utilizing a Near-Infrared Spectroscopy (NIRS grain analyzer, model 1241) in accordance with the procedures outlined in AACC (2000

Statistical Analysis

The data collected were analyzed using analysis of variance (ANOVA) via the PROC GLM procedure in SAS software (version 9.0; SAS, 2004), which is suitable for a Randomized Complete Block Design (RCBD). Comparisons of means were conducted employing the Least Significant Difference (LSD) test at a significance level of 5% ($p < 0.05$).

Result and discussion

The analysis of variance result showed that there were significant difference ($p < 0.001$ among tested varieties for days to heading, grain filling period, plant height, spike length, biomass yield and grain yield; similarly Days to maturity, grains per spike and thousand kernel weight ($p < 0.05$) at Debre Markos on- station.

Biomass yield ranged from 3000.00 to 7416.67 kg. The maximum biomass yield was recorded by variety HB1964 (7416.67 kg h-1) followed by Bekoji-1(7083.33 kg h-1) and IBON174/03 & EH1847 (6833.33 kg h-1). In this study the variety HB1964 which record the longest spike length also records maximum biomass yield and the second maximum grain yield scorer at Debre-Markos on station. Thousand kernel weight should be greater than 45 g for two –rowed barley and greater than 42 g for six-rowed barley (Anonymous, 2012) In this study the mean kernel weight of the varieties ranged from 43.00 g for Grace variety and 66.83 g for HB1964; Thus the analysis result indicated that all tested varieties are at acceptable rang of standard requirement for industry except Grace variety (43.00).

Grain yield being a quantitative trait is a complex character of any crop which ranged from 1029.58 to 3125.00 kg h-1 .Among tested genotypes IBON174/03 scored maximum grain yield (3125.00 kg h-1) followed by HB1964 (2929.17 kg h-1) and M-21(2508.33 150 kg h-1)..The overall analysis of variance result indicated that IBON174/03, HB1964 and M-21 showed good agronomic performance and high yielder varieties

Table 2
The mean agronomic performance of malt barley varieties during 2019 and 2020 main cropping season at Debre Markos on-station

Trt No	Variety	DH	DM	GFP	PH	SPL	GPS	BMY	GY	TKW
1	HB1964	68.67	110.67	42.00	95.73	10.34	29.73	7416.67	2929.17	66.83
2	HB1963	71.33	110.00	38.67	83.27	6.72	27.87	5666.67	1933.33	59.50
3	IBON174/03	65.33	109.00	43.67	79.03	7.30	26.67	6833.33	3125.00	54.67
4	Bekoji-1	70.33	112.67	42.33	104.40	6.76	29.60	7083.33	2292.29	55.33
5	EH1847	66.00	111.67	45.67	95.63	7.49	26.00	6833.33	2354.79	50.83
6	Bahati	71.00	111.67	40.67	91.40	6.84	27.33	4666.67	1485.21	63.67
7	Sabini	66.00	111.33	45.33	74.23	7.78	28.00	4500.00	1904.38	52.67
8	Fanaka	70.33	108.00	37.67	74.53	6.30	25.20	4583.33	1044.38	53.50
9	Holker	70.00	111.00	41.00	89.47	6.42	29.33	5083.33	1563.33	54.00
10	Traveller	71.67	112.00	40.33	56.33	7.93	26.80	4666.67	1677.92	47.33
11	Planet	72.33	110.00	37.67	58.03	7.93	28.93	3500.00	1303.13	48.83
12	Fatima	72.00	109.67	37.67	65.87	8.01	27.73	3916.67	1296.25	51.67
13	Henerik	72.00	109.00	37.00	60.43	8.15	27.07	3000.00	1029.58	58.67
14	Grace	71.00	108.33	37.33	61.70	8.98	26.93	3416.67	1205.00	43.00
15	M-21	66.00	111.67	45.67	88.97	7.17	25.60	6666.67	2508.33	61.00
Mean		**69.60**	**110.44**	**40.84**	**78.60**	**7.61**	**27.52**	**5188.89**	**1843.47**	**54.77**
CV		**1.181**	**1.476**	**4.430**	**2.66**	**4.406**	**5.01**	**2.926**	**4.240**	**13.392**
LSD		**1.855**	**3.68**	**4.082**	**13.022**	**1.018**	**3.116**	**1802.6**	**772.39**	**16.549**
P-value		**< .0001**	**0.0293**	**< .0001**	**< .0001**	**< .0001**	**0.0046**	**< .0001**	**< .0001**	**0.0337**

Where; DH = Day to heading, DM=days to maturity, PH=plant height, SPL=spike length, KPS= kernels per spick, BMY= biomass yield, GY=grain yield kg h^{-1} and TKW=thousand Kernel weight,

The analysis of variance showed that the tested varieties differed significantly ($p < 0.05$) for grain filling period, and were highly significant ($p < 0.001$) for days to heading, days to maturity, plant height spike length, biomass yield and grain yield. Biomass yield ranged from 3000.00 to 6916.67kg. The maximum biomass yield was recorded by variety IBON174/03 (6916.67 *kg* h^{-1}) followed by M-21(6083.33 *kg* h^{-1}) and EH1847 (5888.89 *kg* h^{-1}.). The mean of varieties for Grain yield ranged from 618.33 to 2347.15 *kg* h^{-1}.Among tested genotypes IBON174/03 scored maximum grain yield (2347.15 *kg* h^{-1}) followed by M-21(2094.24 *kg* h^{-1}) and HB1964 (1847.57 *kg* h^{-1}); Generally analysis of variance result indicated that IBON174/03 (2347.15 *kg* h^{-1}) followed by M-21(2094.24 *kg* h^{-1}) and HB1964 (1847.57 *kg* h^{-1}) performed well and high yielder varieties at Sinan district .

Table 3
The mean agronomic performance of malt barley varieties during 2019 and 2020 main cropping season at Sinan District

Trt	Variety	DH	DM	GfP	PH	SL	BMY	GY	TKW
1	HB1964	64.33	107.67	43.33	79.100	8.09	4638.89	1795.00	59.00
2	HB1963	70.67	113.00	42.33	63.467	5.83	4361.11	1165.21	53.17
3	IBON174/03	60.67	100.33	39.67	71.567	6.28	6916.67	2347.15	58.17
4	Bekoji-1	65.33	102.67	37.33	82.433	6.16	5416.67	1418.06	51.50
5	EH1847	62.00	102.00	40.00	77.000	6.62	5888.89	1847.57	50.50
6	Bahati	66.67	105.33	38.67	74.267	5.76	4083.33	1035.21	50.50
7	Sabini	62.33	102.33	40.00	59.433	6.48	4111.11	1071.18	39.00
8	Fanaka	64.33	103.33	39.00	57.700	5.66	3250.00	778.89	45.83
9	Holker	68.00	107.00	39.00	67.633	5.56	4361.11	908.82	51.50
10	Traveller	67.00	111.67	44.67	53.700	7.25	5486.11	1713.33	52.67
11	Planet	69.67	109.67	40.00	45.367	6.42	3000.00	714.51	46.17
12	Fatima	70.33	108.33	38.00	50.033	5.86	4027.78	896.53	52.00
13	Henerik	68.33	106.67	38.33	46.333	6.06	3750.00	618.33	49.50
14	Grace	69.00	109.67	40.67	48.667	6.98	3722.22	1096.04	43.83
15	M-21	62.00	104.33	42.33	80.633	6.52	6083.33	2094.24	48.00
Mean		66.04	106.27	40.22	63.822	6.37	4606.48	1300.00	50.09
CV		2.97	2.30	5.60	2.73	5.56	4.555	4.462	13.54
LSD		4.427	5.533	5.087	10.271	0.9847	2069.7	659.03	15.303
P - value		< .0001	< .0001	0.0158	< .0001	< .0001	< .0001	< .0001	0.1082

Where; DH = Day to heading, DM=days to maturity, PH=plant height, SPL=spike length, KPS= kernels per spick, BMY= biomass yield, GY=grain yield and TKW=thousand Kernel weight

Combined Analysis of Variance

The combined analysis of variance conducted over two locations and two years indicated highly significant differences ($P < 0.01$) in grain yield, plant height, spike length, biomass yield, days to heading, and the grain filling period. Additionally, significant differences ($P < 0.05$) were found for days to maturity and thousand-grain weight. While the environment had a considerable impact on most of the parameters assessed, the grain filling period exhibited no significant response, implying that this particular trait was relatively stable and not influenced by environmental changes.

Phenological Traits

Days to Heading

The average time to heading among the tested varieties ranged from 63 to 71 days. The longest time to heading (71 days) was noted in the varieties HB1963, Planet, and Fatima, whereas IBON174/03 was the earliest to head at 63 days. This finding is consistent with Molla et al. (2017), who also identified IBON174/03 as a short-duration variety (63 days).

Days to Maturity

The average maturation period varied from 104 to 111 days. Varieties IBON174/03, Fanaka, EH1847, and Sabini showed the shortest maturation durations (104, 105, and 106 days, respectively), making them the earliest maturing genotypes among those evaluated.

Grain Filling Period

The duration of the grain filling period ranged from 37.74 to 44 days. The longest grain filling time was observed in variety M-21 at 44 days, while Henerik had the shortest at 37.74 days.

Table 4
; The combine analysis of malt barley varieties for phonological traits

Trt	Variety	DH	DM	GfP
1	HB1964	66.5	109	42.67
2	HB1963	71	111.5	40.5
3	IBON174/03	63	104.67	41.67
4	Bekoji-1	67.83	107.67	39.83
5	EH1847	64	106.83	42.83
6	Bahati	68.83	108.5	39.67
7	Sabini	64.17	106.83	42.67
8	Fanaka	67.33	105.67	38.33
9	Holker	69	109	40
10	Traveller	69.33	111.83	42.5
11	Planet	71	109.83	38.83
12	Fatima	71.17	109	37.83
;13.	Henerik	70.17	107.83	37.67
14	Grace	70	109	39
15	M-21	64	108	44
Mean		**67.82**	**108.36**	**40.53**
CV		**2.32**	**2.73**	**6.45**
LSD		**2.41**	**4.53**	**3.99**
Trt		***	**	***
loc		***	***	**ns**

Where; DH = Day to heading, DM=days to maturity, GfP= grain filling period

Morphological Data

Plant Height

The analysis of plant height revealed that the tallest varieties were Bekoji-1 (93.42 cm), HB1964 (87.42 cm), and EH1847 (86.32 cm). On the other hand, the shortest plants were Planet (51.70 cm), Henerik (53.38 cm), and Grace (55.18 cm). These

differences are largely due to genetic variations among the varieties. Gezahegn and Kefale (2016), along with Jemal et al. (2015), pointed out that such discrepancies in plant height are usually the result of interactions between a variety's genetic characteristics and the environmental factors it faces

Spike Length

In terms of spike length, the longest was found in variety HB1964 (9.22 cm), while the shortest was noted in variety Fanaka (5.98 cm).

Table 5
; The combine analysis of malt barley varieties for morphological traits

Trt	Variety	PH	SPL
1	HB1964	87.42	9.22
2.	HB1963	73.37	6.28
3.	IBON174/03	75.30	6.79
4.	Bekoji-1	93.42	6.46
5.	EH1847	86.32	7.05
6.	Bahati	82.83	6.30
7.	Sabini	66.83	7.13
8.	Fanaka	66.12	5.98
9.	Holker	78.55	5.99
10.	Traveller	55.02	7.59
11.	Planet	51.70	7.18
12.	Fatima	57.95	6.93
;13.	Henerik	53.38	7.10
14.	Grace	55.18	7.98
15.	M-21	84.80	6.85
Mean		**71.21**	**6.99**
CV		**2.75**	**5.69**
LSD			
Trt		***	***
loc		***	***

WherePH=plant height, SPL=spike length

Yield-Related Traits

Biomass Yield

The average biomass yield among the varieties tested ranged from 3,250 to 6,875 kg ha^{-1}. The highest yield was recorded for variety IBON174/03 at 6,875 kg ha^{-1}, followed closely by M-21 (6,375 kg ha^{-1}) and EH1847 (6,371.11 kg ha^{-1}).

Grain Yield

The average grain yield showed significant variation, from 832.96 kg ha⁻¹ for Henerik to 2,736.08 kg ha⁻¹ for IBON174/03. The top three varieties were IBON174/03 (2,736.08 kg ha⁻¹), HB1964 (2,362.08 kg ha⁻¹), and M-21 (2,301.28 kg ha⁻¹), all surpassing the overall mean yield. In contrast, the lowest yields were from Henerik (823.96 kg ha⁻¹), Fanaka (911.63 kg ha⁻¹), and Planet (1,008.82 kg ha⁻¹). Based on these findings, IBON174/03, HB1964, and M-21 are recognized as the most appropriate varieties for the study area.

Thousand-Kernel Weight (TKW)

The thousand-kernel weight results ranged from 43.42 g for variety Grace to 62.92 g for variety HB1964. HB1964 had the highest weight (62.92 g), followed by Bahati (57.08 g) and IBON174/03 (56.42 g). According to industry standards, the thousand-kernel weight must exceed 45 g for two-rowed barley and 42 g for six-rowed barley (Anonymous, 2012). Therefore, the analysis shows that all tested varieties meet acceptable industry standards, except for Grace (43.42 g).

Table 6
; The combine analysis of malt barley varieties for yield and yield related traits

Trt	Variety	BMY	GY	TGW
1	HB1964	6027.78	2362.08	62.92
2.	HB1963	5013.89	1549.27	56.33
3.	IBON174/03	6875.00	2736.08	56.42
4.	Bekoji-1	6250.00	1855.17	53.42
5.	EH1847	6361.11	2101.18	50.67
6.	Bahati	4375.00	1260.21	57.08
7.	Sabini	4305.56	1487.78	45.83
8.	Fanaka	3916.67	911.63	49.67
9.	Holker	4722.22	1236.08	52.75
10.	Traveller	5076.39	1695.63	50.00
11.	Planet	3250.00	1008.82	47.50
12.	Fatima	3972.22	1096.39	51.83
;13.	Henerik	3375.00	823.96	54.08
14.	Grace	3569.44	1150.52	43.42
15.	M-21	6375.00	2301.28	54.50
Mean		**4897.69**	**1571.74**	**52.43**
CV		**5.44**	**5.65**	**13.8**
LSD				**11.05**
Trt		***	***	**
loc		***	***	**

Where; BMY= biomass yield, GY=grain yield and TKW=thousand Kernel weight,

Quality Parameters of Malt Barley Varieties

The analysis of variance concerning the assessed quality parameters demonstrated significant variability among the evaluated varieties (Table 5).

Extract Content and Friability

The average extract content varied from 76.65% for EH1847 to 81.83% for Planet. Varieties such as Planet (81.83%), Traveller (81.55%), Fatima (81.48%), and Henerik (81.44%) exhibited remarkably higher levels of malt extract compared to the other varieties, thereby indicating enhanced malt modification. Friability, which serves as an indicator of malt grain cell wall modification and kernel hardness (Rani & Bhardwaj, 2021), was found to be highest in Planet (87.57%), followed by Traveller (81.64%) and Henerik (80.67%). These elevated values imply excellent lautering performance. In contrast, HB1964 (52.11%), EH1874 (52.50%), and M-21 (53.13%) presented the lowest friability values, signifying under-modification, which may lead to inadequate wort clarification and diminished lautering efficiency.

Protein and β-Glucan Content

The mean protein content of the kernels ranged from 7.46% for Planet to 11.32% for M-21. Based on the thresholds established by the National Standard Authority (9.5% to 11.5%), only M-21 (11.32%), EH1847 (10.65%), IBON174/03 (9.96%), and HB1964 (9.77%) met the acceptable range. The majority of other varieties fell short of the 9.5% minimum protein level. The β-Glucan content exhibited considerable variation, ranging from 90.09 to 729.61 mg/l. The highest concentrations were observed in IBON174/03 (729.61), EH1874 (726.42), and HB1964 (689.27). This subset of varieties also recorded the lowest friability scores. Elevated β-Glucan levels, when coupled with low friability, result in inadequate malt modification and incomplete hydrolysis of cell walls. Habschied et al. (2020) noted that increased β-Glucan impedes enzyme diffusion during the mobilization of kernel reserves, thereby negatively affecting the overall quality of the malt. Conversely, Planet (90.09), Henerik (232.12), and Fatima (304.53) displayed the lowest β-Glucan contents, which, as supported by Narzis (2012), correlates with significantly improved malting performance.

For optimal malting quality characterized by high extract levels and exceptional modification, the varieties Planet, Traveller, and Henerik are recommended. To fulfill industrial protein standards, M-21, EH1847, IBON174/03, and HB1964 are identified as suitable alternatives, with IBON174/03 and M-21 particularly emphasized for their commendable performance in the East Gojjam highlands.

Table.7 The mean analysis of malt barley varieties for Quality Parameter

Trt	Variety	EC	FB	PC	ßGl
1	HB1964	78.73	52.11	9.77	689.27
2.	HB1963	80.90	74.93	7.79	399.16
3.	IBON174/03	78.70	54.09	9.96	729.61
4.	Bekoji-1	80.30	67.69	8.88	417.71
5	EH1847	76.65	52.50	10.65	726.42
6.	Bahati	80.07	66.59	9.20	639.51
7.	Sabini	79.80	59.09	9.27	623.04
8.	Fanaka	78.77	60.82	8.84	590.05
9.	Holker	80.32	70.61	8.40	418.81
10.	Traveller	81.55	81.64	8.78	377.35
11.	Planet	81.83	87.57	7.46	90.09
12.	Fatima	81.48	76.34	8.53	304.53
13.	Henerik	81.44	80.67	8.48	232.12
14.	Grace	80.26	75.29	8.58	369.98
15.	M-21	77.14	53.13	11.32	621.51
Mean		**79.86**	**67.54**	**9.06**	**481.94**
CV		1.91	11.42	10.14	20.70
LSD		3.4578	17.406	2.0744	225.1
P-values		0.0043	< .0001	0.0015	< .0001

Where; EC=Extract content(% dm), FR=, Friability (%), PC= protein content (% dm), BGC= ß-Glucan content (mg/L)

Conclusion and Recommendation

Conclusion

This study was conducted over two consecutive cropping seasons (2019–2020) in the Debre Markos and Sinan districts to assess the performance of 15 malt barley varieties. The findings indicated substantial genetic variability among the varieties concerning phenology, grain yield, and malting quality. Among the evaluated genotypes, IBON174/03, HB1964, and M-21 emerged as the leading performers with respect to agronomic traits, achieving the highest grain yields and biomass. In terms of quality, varieties such as Planet, Traveller, and Henerik exhibited superior malt extract and friability, alongside low β-glucan content. Nevertheless, regarding compliance with the national industrial standard for protein levels (9.5%–11.5%), only M-21, EH1847, IBON174/03, and HB1964 fell within the acceptable range. Notably, HB1964 displayed a balanced profile, combining high yield with acceptable industrial protein levels.

Recommendation

1. 1. For Farmers: It is strongly advised that the varieties IBON174/03 and HB1964 be adopted for large-scale production in the highlands of the East Gojjam Zone, owing to their excellent grain yield and adaptability.
2. 2. For the Brewing Industry: Breweries and maltster factories are encouraged to adopt contract farming arrangements centered on HB1964, as it successfully reconciles high farm productivity with the necessary industrial protein standards.

3. 3. For Future Research: Given that high-yielding varieties like IBON174/03 displayed lower friability and elevated β-glucan levels, future breeding initiatives should aim to enhance the malting quality of these high-performing agronomic lines.

Declarations

Author Contribution

Mulugeta ; proposal writing ,data analysis ,wrote the full manuscript Alehegn; manage the research field ,datacollection data analysis

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