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Research Article

Evaluation of Seven Oat (*Avena sativa*) Genotypes for Biomass Yield and Quality Parameters under Different Locations of Western Oromia, Ethiopia

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Recognizing the potential and importance of cultivating improved forage crops as a means of tackling the recurrent feed shortage facing the study area, seven oat genotypes were tested in randomized complete block design with three replications across two locations for three growing seasons (2014, 2015, and 2016). The study was aimed to evaluate dry matter (DM) and digestible organic matter yield and nutrient composition of oat genotypes. The study revealed that oat genotypes responded differently for herbage dry matter (DM) and digestible organic matter (OM) yield, and quality parameters in both study locations. Averaged over the seven oat genotypes, herbage DM and digestible OM yield. recorded at Bako were higher than Boneya Boshe location across the study periods. The ash ($P > 0.05$) content did not vary among oat genotypes at both testing locations, while variation was observed for DM, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), in vitro digestibility, and metabolizable energy (ME) constituents. In general, genotypes ILRI 6710 and 5453 showed higher herbage DM and digestible OM yield. Moreover, the two genotypes are also higher in their in vitro digestibility value and ME, DM, and CP contents but relatively lower in NDF, ADF, and ADL fiber constituents, and thus, they are recommended for wider cultivation.

1. Introduction

In Ethiopia, livestock is an integral component of the agricultural sector with a large bovine population which includes 59.5 and 60.9 million cattle and shoat, respectively [1]. Despite this large number of cattle and shoat population owned by the country, productivity per animal is very low, and hence, its contribution to the overall economy is much less than expected. Among the multiple factors, feed shortage in both quantity and quality is considered the most important limiting factor hindering animal production in Ethiopia [2]. The scarcity of green forage and grazing resources in the country has made the livestock suffer continuously with malnutrition resulting in their production potentiality at the suboptimum level as compared to other African countries [3]. Diriba et al. [4] reported that the cereal straws and native grass hay commonly used as dairy cattle feed in the Western part of Ethiopia, where the present study was carried, were observed to contain considerably the low crude protein levels of 3.4% and 5.0%, respectively. Suggesting a great deal of work is needed in this regard in Ethiopia in general and the study area in particular. Therefore, for a more efficient and productive livestock industry, the cultivation of nutritious and high-yielding fodder varieties is needed.

One such fodder variety is oat (*Avena sativa*) which is an annual cereal, widely grown as fodder in temperate and subtropical countries [5]. Oat is well adapted to a wide range of soils and relatively tolerant of moisture stress, waterlogging, and frost. It can be a good source of animal feed in the dry season if harvested at the right stage of growth, cured, and stored as hay. It is also a quick-growing, palatable, succulent, and nutritious fodder crop [6]. Based on Mut et al. [7] reports who evaluated oat genotypes of worldwide origin, oat could produce hay yield ranged from 6.03 to 11.83 t/ha, crude protein from 58.8 to 136.4 g/kg DM, acid detergent

fiber from 333.2 to 424.8 g/kg DM, and neutral detergent fiber from 522.5 to 652.4 g/kg DM.

Literature reports revealed that [8–10] oat forage yields are very variable, depending on year and location. Its yield performance is a product of the genotype and the environment in which the crop has been grown. This suggests evaluation of the performance of oat genotypes across diverse environmental conditions has paramount importance for selecting superior cultivars in both quality and quantity for the target environments. The local oat variety (Jasari), which is under production and widely adapted to the current study area, is very low in fodder yield as it is very old and its capacity lowered to produce high-forage yield. Since agricultural land is decreasing from time to time, an increase in forage availability could only be achieved by increasing the yield per unit area. Thus, there is a strong need to develop high yielding and more nutritive varieties of fodder oat. Therefore, keeping in view the scarcity of quality fodder and the necessity of developing improved high yielding varieties, the current study was undertaken to identify the forage yield performance, nutritive value, and digestibility characteristics of oat genotypes grown under different locations of Western Oromia, Ethiopia.

2. Materials and Methods

2.1. Locations. The study was conducted at two locations, Bako Agricultural Research Center (BARC) and Boneya Boshe subsite, located in the Western part of Oromia regional state, Ethiopia. Bako lies at an altitude of 1650 m above sea level, whereas Boneya Boshe, one of the subsites of BARC, is situated at an altitude of 1645 m above sea level. Both locations received approximately similar rainfall during the study periods ranged from 1431 to 1500 mm (BARC metrological station). According to Wakene [11], the soil type of the Boneya Boshe site was reddish-brown and clay loam in texture, while that of Bako was sandy clay.

2.2. Planting Materials. Planting materials used for this study were obtained initially from the International Livestock Center for Africa (ILCA), now the International Livestock Research Institute (ILRI). Then, the seven genotypes used for the current study were selected based on their adaptability to the subhumid climatic condition of Western Oromia, Ethiopia, from the previous screening and preliminary variety trial work carried at Bako Agricultural Research Center.

2.3. Experimental Land Preparation and Planting. In both locations, an appropriate experimental site was selected. Based on the nature of the soil, the land was well plowed and leveled out for ease of layout and planting. A total of twenty-one plots of $3 * 2$ m were established out and demarcated with a spacing of 1.5 and 2 m between each plot and block, respectively, at all sites. Oat genotypes were sown at a uniform seeding rate of 70 kg/ha across locations and periods, and thus, seeds were drilled in a row with the spacing of 30 cm between each row. The plantation was done in late June across locations throughout the study period. Diammonium phosphate (DAP) and urea fertilizer were applied to all plots during plantation at a rate of 100 kg/ha where a split application was used for urea. Every routine experimental management practices were carried uniformly at all sites during the study periods.

2.4. Treatment Description and Experimental Design. Seven oat (*Avena sativa*) genotypes were studied for their forage and digestible yield, quality-related attributes, and in vitro digestibility characteristics at two locations (Bako and Boneya Boshe subsites) during the years 2014, 2015, and 2016. The genotypes evaluated across years and locations were ILRI 6710, ILRI 5453, ILRI 5518, ILRI 6207, ILRI 712, ILRI 8237, and Jasari (check). Among the genotypes tested, Jasari was the oldest and widely adapted variety to the climatic condition of the study areas and thus used as a check in the current study. The experiment was arranged in a randomized complete block design with three replications during the three consecutive experimental periods in both testing locations.

2.5. Herbage Dry Matter and Digestible Yield Measurement. At 50% flowering stages, the two middle rows of each plot were harvested for herbage yield determination. The fresh weight of the cut biomass was measured just after mowing with suspended field balance. Then composite subsamples of 300 gm per treatment were taken from each replication and oven-dried at 65°C for 72 hrs until a constant weight was obtained to determine the herbage dry matter yield. On the contrary, digestible herbage yield was estimated as the product of total herbage yield and in vitro digestibility percentage divided by a hundred [12].

2.6. Nutrient Composition and In Vitro Digestibility Analysis. Samples of feed were dried in an oven at 65°C for 72 hours and ground to pass through a 1 mm sieve screen size. Then, dry matter (DM), nitrogen content (N), and ash were analyzed according to the procedure of AOAC [13], whereas organic matter (OM) was calculated by deducing the value of ash content from 100. Crude protein (CP) was estimated by the multiplying N value by a factor of 6.25 as $N * 6.25$. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed using the procedures of Van Soest et al. [14]. The in vitro organic matter digestibility (IVOMD) was determined using the Tilley and Terry [15] method, whereas the metabolizable energy (ME) result was estimated from IVOMD using the equation of Uttam et al. [16]: ME (MJ/kg DM) = 0.15* IVOMD.

2.7. Data Analysis. Analysis of variance (ANOVA) following the general linear model (GLM) procedure of SAS [17] version 9.3 was used to analyze the data, and significantly different means were separated using the least significant difference (LSD) test at a 5% level of significance. For herbage DM, crude protein and digestible organic matter

yield parameters such as genotype, environment, year, and their interaction were considered as independent variables in the model indicated as $Yijkl = \mu + Gi + Ej + Yk + (Gi * Ej * Yk) + Bl + Eijkl$, where $Yijkl$ = response variable; μ = overall mean; Gi = genotypic effect; Ej = environmental effect; Yk = year effect; $Gi * Ej * Yk$ = interaction effect of genotype, environment, and year; Bl = block effects; and $Eijkl$ is the random error.

Regarding quality traits, a composite sample per genotype from each location was taken in each experimental year; thus, a year was considered as a replicate. Hence, the data were fitted to the following model: $Yijk = \mu + Gi + Lj + (Gi * Lj) + Yk + Eijk$, where $Yijk$ refers to the herbage quality traits, μ = overall mean, Gi = genotypic effects, Lj = location effects, $(Gi * Lj)$ = interaction effects of genotype by location, Yk = year effect (replicate) and $Eijk$ is the random error.

3. Results and Discussion

3.1. Environment and Interaction Effect on the Performance of Oat Genotypes. Analysis of the variance for herbage dry matter (DM) and digestible organic matter (OM) yield, and quality parameters of the seven oat genotypes combined across the environment is shown in Table 1.

Environment, genotypes, and their interaction showed a significant effect on the herbage DM and digestible OM yield. Genotypic main effects showed a significant effect for all quality traits; however, crude protein, neutral detergent fiber, ash, in vitro organic matter digestibility, and metabolizable energy traits were not affected by the environmental main effects. Except for ash, all quality traits were significantly affected by the interaction of genotypes with the environment. The significant genotype by environment interaction effects demonstrated that genotypes responded differently to different environments confirming the need to assess the performance of oat genotypes across environments to identify genotypes with stable and superior yield across environments. In conformity to the finding of the current study, Gezahegn et al. [18] who studied Napier grass genotypes across five environments found that Napier grass genotypes respond differently for agronomic performance, yield stability, and nutritive values across the test environments. Similarly, Mulisa and Alemayehu [19] reported that *Trifolium* species responded differently for agronomic traits across the test environments. A similar trend was also reported by Ilknur et al. [20] who studied nine cowpea genotypes across two environments. This could be a result of changes in a cultivar's relative performance across environments due to differential responses of the genotypes to various edaphic, climatic, and biotic factors [21].

3.2. Herbage Dry Matter Yield. The herbage dry matter yield of the seven oat genotypes tested at two locations over the three experimental years is shown in Table 2. The study result indicates that for the genotypic effect, the average herbage dry matter yield ranged from 7.36 t/ha for ILRIL 5518 to 9.03 t/ha for ILRI 6710 followed by ILRI 5453 yielding 8.56 t/ha, with a mean value of 8.1 t/ha. Of the total genotypes tested, only four genotypes produced higher mean values over the overall average yield, suggesting the genotypes are distinctly different for herbage DM yield attributes. Concerning environmental grouping, the mean value of herbage dry matter yield ranged from the lowest value 6.37 t/ha recorded in 2016 at Boneya Boshe location to the highest value 11.34 t/ha obtained in 2014 at Bako location. The variation in environmental conditions was reflected by the large differences in the average herbage dry matter yield observed across the environment, which might be attributed to the variability in amount and distribution in rainfall, which is expected to vary greatly across locations and may influence the performance of oat genotypes.

For combined analysis, the highest mean herbage dry matter yield of 13.57 t/ha was obtained from ILRI 5453 in 2014, and a significantly lower mean value of 4.85 t/ha was observed in ILRI 712 in 2016. Generally, the results conform to the findings reported by Dawit and Mulusew [22] and Numan et al. [23] reported in a range from 7.7 to 10.3 t/ha and 7.5 to 12.8 t/ha, respectively. However, the finding reported by Getnet et al. [5], who characterizes 21 oat genotypes, was relatively higher (10.13 to 15.39 t/ha) than the yield obtained in the present study. This might be attributed to the agroecological difference in which the studies were carried, which was midaltitude in the case of the current study.

3.3. Digestible Organic Matter (OM) Yield. The digestible organic matter yield of the seven oat genotypes tested across two locations for three experimental years is shown in Table 2. For the genotypic effect, the average digestible OM yield ranged from the significantly lower 4.85 t/ha for ILRI 5518 to the higher 5.96 t/ha for ILRI 6710 which is followed by 5.56 t/ha for ILRI 5453. The higher digestible OM yield of ILRI 6710 and IRL 5453 suggested that, of the total herbage DM yield, 66% and 64.95%, respectively, is digestible which is relatively higher than the check which gave 60.34% digestible yield. A key measure of the nutritive value of feedstuff is digestibility, either in vitro or in vivo [24]. Thus, while evaluating forage crops, dry matter yield and/or digestibility value should not be the only parameters to be considered. Rather, it is the digestible yield that describes the overall and actual productivity of quality forage crops. Based on environmental grouping, the higher mean digestible OM yield 7.05 t/ha was recorded in 2014 at the Bako location, whereas a significantly lower mean digestible OM yield 3.94 t/ha was received in 2016 at the Boneya Boshe location. For combined analysis, the significantly higher digestible OM yield mean value 8.24 t/ha was found from ILRI 5453 in 2014 while the lowest average value 2.8 t/ha was recorded for ILRI 712 in 2016.

3.4. Nutrient Composition of the Seven Fodder Oat Genotypes at Two Locations. The mean nutrient composition of the seven oat genotypes evaluated at two locations is presented in Table 3. Except for ash content, oat genotypes showed variation in their nutrient constituents at both testing

Table 1: Combined analysis of variance for herbage dry matter (DM) and digestible organic matter (OM) yield and quality parameters of the seven oat genotypes tested across six and two environments, respectively.

Parameters (t/ha)	F probability ($P = 0.05$)			Mean	CV (%)	R^2
	Genotype	Environments	$G * E$			
Forage DM yield	0.0001	<0.0001	<0.0001	8.09	13.06	0.87
Digestible OM yield	<0.0001	<0.0001	<0.0001	5.02	13.08	0.88
DM (%)	<0.0001	0.0363	0.0143	55.15	3.04	0.89
CP (% DM)	<0.0001	0.4786	0.0346	5.47	11.72	0.83
NDF (% DM)	<0.0001	0.7685	<0.0001	70.72	1.89	0.81
ADF (% DM)	<0.0001	0.0021	<0.0001	57.29	1.89	0.98
ADL (% DM)	<0.0001	<.0001	<0.0001	4.87	7.2	0.95
Ash (% DM)	0.0159	0.3461	0.1939	8.74	7.54	0.58
IVOMD (% DM)	<0.0001	0.2419	0.0108	61.91	2.07	0.86
ME (MJ/kg DM)	<0.0001	0.2418	0.0103	9.29	2.07	0.86

[a,b,c]Means within a row with different superscripts differ significantly ($P < 0.05$); EMS = error mean square.

Table 2: Herbage dry matter (DM) and digestible organic matter (OM) yield mean values of the seven oat genotypes tested at each location over the three years (2014, 2015, and 2016).

Genotypes	Herbage DM yield							Digestible OM yield						
	2014		2015		2016		Combined	2014		2015		2016		Combined
	BK	BB	BK	BB	BK	BB		BK	BB	BK	BB	BK	BB	
ILRI 5453	13.57^{a}	12.89^{a}	7.87	6.74^{ab}	7.27^{bc}	7.16^{a}	8.56^{ab}	8.24^{a}	6.24^{b}	5.06^{a}	4.43^{b}	4.67^{ab}	4.71^{a}	5.56^{a}
ILRI 5518	8.23^{e}	6.81^{c}	8.54	6.81^{ab}	8.13^{abc}	5.64^{ab}	7.36^{d}	5.05^{c}	4.17^{c}	5.24^{a}	4.17^{bc}	4.99^{ab}	3.45^{bc}	4.51^{c}
ILRI 6207	12.83^{ab}	7.09^{c}	7.33	6.15^{b}	7.82^{abc}	6.76^{ab}	7.74^{cd}	6.92^{b}	4.22^{c}	4.51^{a}	3.65^{bc}	4.82^{ab}	4.02^{abc}	4.69^{bc}
ILRI 6710	11.97^{bc}	12.38^{a}	7.6	7.99^{a}	8.33^{ab}	5.89^{ab}	9.03^{a}	8.18^{a}	8.25^{a}	4.97^{aa}	5.33^{a}	5.45^{a}	3.93^{ab}c	5.96^{a}
ILRI 712	10.59^{d}	9.49^{b}	7.59	6.03^{b}	6.66^{cd}	4.85^{b}	8.1^{bc}	6.55^{b}	7.44^{a}	4.69^{a}	3.48^{c}	4.12^{b}	2.8^{c}	4.85^{bc}
ILRI 8237	10.93^{cd}	10.32^{b}	5.97	5.71^{b}	9.24^{a}	7.08^{a}	8.21^{bc}	7.83^{a}	6.24^{b}	3.61^{b}	3.45^{c}	5.58^{a}	4.28^{ab}	4.96^{b}
Jasari	11.25^{cd}	5.65^{c}	7.52	7.11^{ab}	5.07^{d}	7.21^{a}	7.69^{cd}	6.61^{b}	3.42^{c}	4.54^{a}	4.3^{bc}	3.06^{c}	4.36^{ab}	4.64^{bc}
Mean	11.34	9.23	7.49	6.65	7.5	6.37	8.1	7.05	5.71	4.66	4.12	4.67	3.94	5.02
LSD	1.36	1.73	1.4	1.41	1.59	1.99	0.7	0.86	1.09	0.87	0.88	0.97	1.22	0.44
CV	6.74	10.55	10.52	11.94	11.88	17.54	13.06	6.82	10.82	10.52	12.02	11.68	17.45	13.08
$P = 0.05$	***	***	ns	ns	**	ns	***	***	***	*	**	**	ns	***

[a,b,c,d,e]Means within a row with different superscripts differ significantly ($P < 0.05$); *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; BK = Bako location; BB = Boneya Boshe location; ILRI = International Livestock Research Institute.

locations. The average values of DM, CP, NDF, ADL, IVOMD, and ME contents were relatively higher at Bako location while the ADF value was recorded higher at Boneya Boshe. The average DM content ranged from the significantly lower 50.23% for ILRI 6207 to the higher 62.31% for ILRI 6710, followed by 60.93% for ILRI 5453% at Bako location, but both are statistically at par. At Boneya Boshe location, the mean value of DM varied from the lower 50.73% recorded from ILRI 8237 to the higher 60.13% obtained from ILRI 6710 followed by 58.08% recorded for ILRI 5453 with a mean value of 54.57%. In disagreement with the current study, higher DM content from oat genotypes was reported by Usman et al. [25] and Amanuel et al. [26]. In addition to genetic variability, this variation might be related to the difference in rainfall, soil fertility, forage harvesting stage, and other climatic conditions in which the studies were carried.

Oat genotypes showed significant variation in their CP values in both testing locations. At Bako location, the CP content ranged from the lower value 41.0 g/kg DM for ILRI 8237 to the higher value 75.3 g/kg DM for the genotype ILRI 6710 followed by ILRI 5453 having 63.5 g/kg DM with a mean value of 5.55 g/kg DM. At Boneya Boshe location, however, the higher CP value was recorded for genotype ILRI 5453 (67.3 g/kg DM) followed by ILRI 6710 (60.9 g/kg DM) while the lower value was received for genotype ILRI 6207 (36.2 g/kg DM), and the rest of the genotypes are intermediate in their CP content. Except genotypes ILRI 6710 and ILRI 5453, which contained relatively comparable CP with that of the minimum level of CP (70 g/kg DM) required for optimal rumen function and feed intake in ruminants, the rest of the genotypes had lower CP than the critical level [27], implying the need for additional supplemental protein source for these genotypes. Devkota et al. [28] who studied promising oat varieties in combination with legumes reported a CP value ranging from 44.6 to 69.5 g/kg DM, which is in line with the current study result. Similar CP value was also reported by Usman et al. [25] and Fekede et al. [29] reported in a range from 30.1 to 79.8 g/kg DM and 48 to 76 g/kg DM, respectively. These results are, however, much lower than the CP level (97.2–133.6 g/kg DM) reported by Khan et al. [30]. This variation might be

Table 3: Nutrient constituents of the seven oat genotypes at two locations (Bako and Boneya Boshe).

Location	Genotypes	DM%	Nutrient compositions (g/kg DM)						ME (MJ kg/DM)
			CP	Ash	NDF	ADF	ADL	IVOMD	
Bako	ILRI 5453	60.93^{a}	63.5^{ab}	74.4	690.2^{c}	539.9^{d}	33.0^{d}	642.5^{ab}	9.64^{ab}
	ILRI 5518	54.81^{b}	61.2^{bc}	91.2	717.4^{ab}	610.4^{a}	64.0^{a}	613.9^{c}	9.21^{c}
	ILRI 6207	50.23^{c}	41.2^{d}	81.0	699.4^{bc}	610.1^{a}	41.1^{c}	615.2^{bc}	9.23^{bc}
	ILRI 6710	62.31^{a}	75.3^{a}	82.3	685.0^{c}	470.8^{e}	43.1^{c}	653.5^{a}	9.8^{ac}
	ILRI 712	53.45^{b}	57.3^{bc}	90.7	728.7^{a}	578.4^{bc}	68.0^{a}	617.9^{bc}	9.27^{bc}
	ILRI 8237	54.13^{b}	41.0^{d}	94.7	728.7^{a}	590.7^{a}	65.0^{a}	604.4^{c}	9.07^{c}
	Jasari (check)	54.15^{b}	48.6^{cd}	90.5	704.9^{bc}	570.1^{c}	51.9^{b}	603.0^{c}	9.05^{c}
	Overall mean	55.72	55.5	86.4	707.8	567.2	52.3	621.5	9.32
	LSD	3.15	1.3	1.5	2.32	1.94	0.53	2.77	0.41
	CV (%)	3.18	13.15	9.75	1.85	1.93	5.7	2.5	2.49
	$P = 0.05$	***	**	ns	**	***	***	*	*
Boneya Boshe	ILRI 5453	58.08^{ab}	67.3^{a}	81.6	710.4^{bc}	515.6^{d}	34.3^{c}	657.5^{a}	9.86^{a}
	ILRI 5518	52.93^{cd}	55.1^{b}	91.4	690.2^{c}	627.9^{ab}	54.2^{a}	612.5^{b}	9.19^{b}
	ILRI 6207	53.21^{cd}	36.2^{c}	88.8	733.0^{ab}	636.3^{a}	45.5^{b}	594.0^{c}	8.91^{c}
	ILRI 6710	60.13^{a}	60.9^{ab}	90.1	658.8^{d}	477.6^{e}	30.0^{c}	666.7^{a}	10.0^{a}
	ILRI 712	55.31^{bc}	59.0^{ab}	89.5	711.3^{bc}	632.6^{ab}	55.6^{a}	577.5^{d}	8.66^{d}
	ILRI 8237	50.73^{d}	40.2^{c}	83.9	700.5^{c}	546.8^{c}	46.1^{b}	604.2^{bc}	9.06^{bc}
	Jasari (check)	51.63^{d}	59.6^{ab}	93.2	741.5^{a}	613.1^{b}	50.5^{ab}	604.8^{bc}	9.07^{bc}
	Overall mean	54.57	54.0	88.4	706.5	578.6	45.2	616.8	9.25
	LSD	3.04	0.99	0.78	2.3	2.04	0.74	1.63	0.24
	CV (%)	3.13	10.36	4.94	1.83	1.98	9.18	1.49	1.49
	$P = 0.05$	***	***	ns	***	***	***	***	***

^{a,b,c,d}Means within a row with different superscripts differ significantly ($P < 0.05$); *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; ns = nonsignificant; ILRI = International Livestock Research Institute.

attributed to varietal genetic variability and differences in rainfall, soil fertility, and other climatic conditions in which the studies were carried.

Neutral detergent fiber (NDF) content showed significant variation among oat genotypes at both testing locations, ranging from 685 to 728.7 g/kg DM with a mean value of 707.8 and 658.8 to 741.5 g/kg DM with a mean value of 706.5 at Bako and Boneya Boshe locations, respectively. Genotypes ILRI 712 (728.7 g/kg DM) and ILRI 8237 (728.7 g/kg DM) which remained at par contained the higher NDF level, while ILRI 6710 (685 g/kg DM) contained the lower NDF value at the Bako location. However, at Boneya Boshe location, the higher NDF value was recorded for the check (Jasari) (741.5 g/kg DM) while the lower was obtained from ILRI 6710 which gave 658.8 g/kg DM. This result conforms to the finding of Gezahegn et al. [31] who studied 10 Napier grass genotypes across two locations in Ethiopia reported in a range from 728.5 to 785.7 g/kg DM. Moreover, the finding reported by Mut et al. [7] who studied hay yield and quality of oat genotypes of worldwide origin agrees to the result obtained in the current study.

Acid detergent fiber (ADF) and acid detergent lignin (ADL) are the percentage of indigestible and slowly digestible materials in a feed or forage [32] and both have a positive relationship with the ages of the plant. In the current study, the ADF content ranged from the higher value 610.4 (ILRI 5518) and 610.1 (ILRI 6207), which remained at par to the significantly lower value 470 (ILRI 6710) at the Bako location. At Boneya Boshe, the ADF value was higher for ILRI 6207 (636.3.4 g/kg DM), lower for ILRI 6710 (477.6 g/kg DM), and intermediate for ILRI 8237 (546.8 g/kg DM). On the contrary, ADL values ranged among genotypes from the lower value of 33 g/kg DM for ILRI 5453 to 68 g/kg DM for ILRI 712 at Bako location. At Boneya Boshe location, genotypes ILRI 6710 (30 g/kg DM) and ILRI 5453 (34.3 g/kg DM) showed lower ADL values, while ILRI 712 (55.6 g/kg DM) and ILRI 5518 (54. g/kg DM) contained the higher ADL value, and the remaining genotypes remained intermediate in their ADL content. Both the ADF and ADL constituents obtained from the genotypes studied in the current study are in agreement to the finding reported on various studies [7, 25, 28, 33]. All in all, at both testing locations, genotypes ILRI 5453 and 6710 are relatively lower in their both ADF and ADL attributes as compared to the remaining oat genotypes, indicating the two genotypes are more digestible and desirable over the rest of the genotypes tested.

The in vitro digestibility value obtained in the current study at Bako location ranged from the higher value 653.5 g/kg DM for ILRI 6710 followed by ILRI 5453 (642.5 g/kg DM) which remained at par to the significantly lower value 603 for the check (Jasari) with a mean value 621.5 g/kg DM. At Boneya Boshe location, genotypes ILRI 6710 (666.7 g/kg DM) and ILRI 5453 (657.5 g/kg DM) showed the higher in vitro digestibility value, but both are statistically at par, while genotype ILRI 712 (577.5 g/kg DM) gave the lower record in these parameters. The result recorded in the present study from both study location is comparable to the value ranged from 430 to 620 g/kg DM and from 514.9 to 655.8 g/kg DM reported by Fekede et al. [29] and Usman et al. [25], respectively, but was relatively lower than the finding ranged from 686 to 739 g/kg DM reported by

Amanuel et al. [26]. According to Meissner et al. [34], the threshold level of in vitro digestibility percentage below which the feed intake is affected is 65%/650 g/kg DM. Thus, two of the genotypes tested in the present study, ILRI 6710 and 5453, are in line with the value reported to be optimal, indicating the good digestibility potential of these two genotypes which will lead to an increased feed intake as digestibility and feed intake are positively correlated [27].

Averaged over the seven oat genotypes, the metabolizable energy (ME) content was 9.32 MJ/kg DM with the highest content obtained from genotypes ILRI 6710 (9.8 MJ/kg DM) and 5453 (9.64 MJ/kg DM) compared to the remaining genotypes, but both are statistically at par. At Boneya Boshe location, however, the ME value ranged from the higher value 10 MJ/kg DM for genotype ILRI 6710 which is followed by ILRI 5453 (9.86 MJ/kg DM) which remained at par to the significantly lower value 8.66 MJ/kg DM for genotype ILRI 712, and the rest of the genotypes remained as an intermediate for this parameter. The ME content recorded in the present study was higher than the value reported by Mekonnen et al. [35] and Abuye et al. [36] who studied the nutrient composition of natural grass hay around the current study area, reporting 7.49 and 5.32 MJ/kg DM, respectively, but comparable with that of the finding reported by Eroarome [37] who reported the ME content of three tropically improved forage grass species (Batiki, Guinea, and Signal grasses) ranging from 9.4 to 9.5 MJ/kg DM. This result indicates the higher nutritional value of improved forage grasses over that of naturally available pasture grasses.

4. Conclusion

The present study demonstrated that oat genotypes responded differently for herbage dry matter (DM) and digestible organic matter (OM) yield and quality parameters in both study locations, confirming the need to assess the performance of oat genotypes across environments. Both the herbage DM yield and digestible OM yield measurements were relatively higher at the Bako location than Boneya Boshe across the study periods. Among oat genotypes evaluated in the current study, genotypes ILRI 6710 and 5453 showed higher herbage DM and digestible OM yield at both locations over the rest of the genotypes. Regarding quality attributes, except in ash ($P > 0.05$) content, significant variations for DM, CP, NDF, ADF, ADL, in vitro digestibility, and metabolizable energy (ME) contents were observed among oat genotypes at both locations. In general, of the studied genotypes, ILRI 6710 and ILRI 5453 gave the higher herbage DM and digestible OM yield at both study locations. Moreover, the two genotypes also showed higher digestibility percentage, metabolizable energy, DM, and CP content but relatively lower NDF, ADF, and ADL fiber constituents. Thus, both genotypes are recommended for general cultivation due to their better digestibility potential and nutritional quality over the check (Jasari) and the remaining genotypes studied. In general, the information generated in this study suggested that genotypes ILRI 6710 and 5453 have the potential to resolve the recurrent quality of feed scarcity and would serve as a guide to those who would like to adopt an improved fodder oat genotype for ruminant feeding.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

There are no conflicts of interest regarding the publication in this paper.

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