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Research Article

Evaluation of Early Performance Different Provenance of *Moringa stenopetala* (Baker f.) Tree Seedlings under Nursery Level in Central Ethiopia

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ABSTRACT

Moringa stenopetala (Baker f.) Cufodontis is important and valuable indigenous tree species in lowland area of Ethiopia. And also important economically, socially and in the livelihood of farmers and play a key role in ecosystem resilience under climate change scenarios. In this context, the intraspecific variability in plant functional traits can be determinant to improve species fitness for specific area. Therefore, this research aimed to select better provenance for *Moringa stenopetala* in the study area. The provenances of *Moringa stenopetala* trees those have more common and abundantly were selected and seeds were collected and sowed in nursery. After taking appropriate nursery management germination, survival, height, RCD, branch number, above and below ground biomass of seedlings were measured in each provenance. The result shows that, Derashe, Humbo and Arbaminch-zuria provenance seeds were performed significantly higher in most of parameters like growth and biomass parameter (p=0.05). In germination rate is recorded 79% and the lowest is 26.8% from Shewarobit and Konso respectively. The growth parameter of *Moringa stenopetala* show significant difference on height and branch number. Shewarobit (12.75) shows significantly higher in mean branch number than Benatsemay (9.75). Debase (44.05 cm), Humbug (43.48 cm) and Arbaminch (43.12 cm) height which is significantly higher than Benatsemay and Konso (31.2 cm and 30.8 cm respectively). similarly Derashe also have highly significantly differed SFW (21.03 g) RFW (16.6 g) SDW (6.9 g) RDW (5.35 g) of *Moringa stenopetala* from Benatsemay (14.1 g), Metehara (10.9), Konso (3.6), and Zuria wereda (3.3) in SFW, RFW, SDW and RDW respectively. As result, to improve the germination potential selection seed source from different agro ecology is important. In spite of this we have concluded that Derashe is the seed source for the study area (meskan) for *Moringa stenopetala* production from the tested provenance. Derashe recommended as seed source to produce *Moringa stenopetala* seedling in meskan wereda.

Keywords: Biomass; *Moringa stenopetala*; Provenance; Seedling; Germination

INTRODUCTION

Moringa is cultivated in tropical and sub-tropical areas with 100 mm to 1500 mm annual rainfall varying soils types [1]. It has been introduced into gardening systems because of its versatility [2].

Moringa stenopetala is often named as African *Moringa* tree because it is native to southern Ethiopia, North Kenya and Eastern Somalia. *Moringa stenopetal* have 6 m-12 m tall range and up to 60 cm DBH with branched crown more and soft multi-stemmed deciduous tree. Arid, semi-arid and semi-humid at altitudinal ranges from 1000 m.a.s.l to m.a.s.l 1800 is major growing area of Ethiopia. And also found in Southern Rift Valley of Ethiopia an altitude of 390 to about 2200 m.a.s.l in the. Particularly, Konso, Derashe, Gamogofa, Wolayta, Sidama, Bale and Borana widely distributing areas. *M. stenopetala* is agroforestry tree intercropped with agricultural crops as home garden, as living hedges (alley cropping) and windbreaks to reduce the rate of erosion in marginal dry parts of Ethiopia and that supports nearly high population density in South Ethiopia,

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Konso people [3-8]. Sometimes the trees are also used to provide partial shade for crops like sorghum; leaves can also be used as a green [9,10]. About 5-15 trees of *Moringa* per garden with banana, cassava, maize, papaya, coffee, etc., and alley with shade-tolerant leafy vegetables and herbs grown in Arbaminch and around there.

M. stenopetala supply nutrition that decrease hunger; improve health and human nutrition by different food products for African's as all parts of the tree are edible. A single plant of *M. stenopetala* is able to support a large family for several years [11,12]. Some scholars report show that the green leaf of *M. stenopetala* characterized by higher Crude Protein (CP) like 27.3 ± 2.10 by (27.5%) by and (28.2%) by and (36.0%) by. According to, it is believed that *M. stenopetala* relative to *Moringa oleifera* has more vitamin A than carrots, more vitamin C than oranges, more calcium than milk and more iron than spinach [13-17].

As like that of multipurpose tree *Moringa stenopetala* trees characterized by provision, protection and services in nature and have tangible and intangible benefits to societies like ecosystem service like soil fertility and moisture improvement. According to A. Abay, et al., *Moringa stenopetala* tree have higher soil nutrient under its canopy than open area like TN, Avail. P, pH, OM, CEC and cation exchange capacity. In it protection purpose used for water conservation by planting as hedge row and windbreaks to reduce the rate of erosion; sometimes the trees are also used to provide partial shade for crops like *Sorghum*; leaves can also be used as a green manure. On the other hand it has high carbon sequestration potential. According to one study in Japanese, the rate of *Moringa* tree to absorb Carbon Dioxide (CO_2) is fifty times (50 x) higher when compared to the Japanese cedar tree and also twenty times (20 x) higher than that of general vegetation. There is no molecular data, which assess the genetic diversity that exists in the species. The *Moringa* plants collected from different parts of the country show variation in growth rate, nutritive value of leaves, and bitterness of leaves, insect pest and disease and drought resistance (personal communication). The assessment of genetic diversity is important for effective utilization of the germplasm, for breeding programs particularly introducing tree for productivity improvement and identification of conservation priorities. In the study area there are few farmers have *Moringa stenopetela* trees around homestead, but not yet in most farmers (personal observation). To introduce this important tree for farmers identifying better provenance for seed source were required. Therefore, this study is aimed to assess the best provenance of *Moringa stenopetala* for meskan wereda.

MATERIALS AND METHODS

Site description

Mekich is located in Meskan district of Gurage zone, SNNP regional state, Ethiopia. This found around Butajira (capital of the district) town 3 km west, which is 133 km south of Addis Ababa. In terms of topography, the district has diverse topography that consists of plain (55%), sloppy (35%) and mountainous (10%). The study area receives the small rains in March to May and the big rains during June to September with higher concentrations of the rain observed in July and August. According to climatic record near the study area, the mean annual rainfall in the district is 1058 mm (Figure 1).

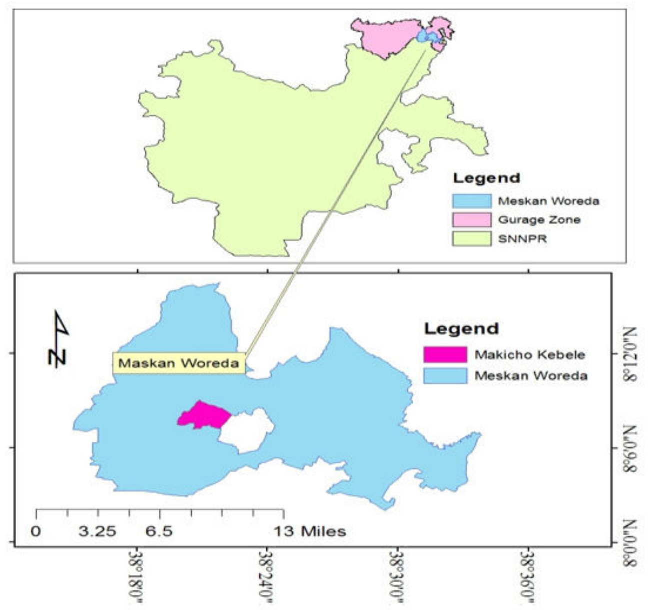

Figure 1: Map of study area.

The district has altitude ranging from 1800-3500 m.a.s.l. and the experimental site is 2000 m.a.s.l. The highest temperature recorded between February and March while coolest is between November and December. The study area is geographically located in central rift valley of Ethiopia. The main parent materials are basalt, ignimbrites, lava, gneiss, volcanic ash, and pumice. According to the dominant soil types of Meskan district includes Eutric Cambisols, Chromic Luvisols, Pellic Vertisols Chromic Vertisols, Eutric Fluvisols and Leptosols.

Experimental design and management

Seeds of *Moringa stenopetala* tree provenance were collect from Central Forestry and Environmental Research Center (CFERC) and other appropriate seed sources. Seed treatment techniques like scarification, was exercised and directly sown in a polythene tube that contained a mixture of local topsoil, forest soil and sand (2 local soil: 2 forest soil: 1 sand), local soil means not vertisols soil rather than it. The size of the polythene tube was 15 cm height and 8 cm diameter used. All pots sown with respective provenance were exposed to similar watering, shading, weeding and hardening practices (Table 1).

Provenance/Treatment

- Konso
- Arbaminch
- Zuria wereda
- Humbo
- Derasha
- Kindo Koysha
- Shewarobit
- Metehara
- Benatsmay
- Meskan

Table 1: Geographical location of provenance.

No.	Provenance	Altitude (m.a.s.l)	Latitude (N)	Longitude (E)
1	Konso	1284	5°20'542"	37°26'905"
2	Arbaminch	1190	6°62'101"	37°34'895"
3	Derashe	1320	5°43'529"	37°24'390"
4	Humbo	1484	6°71'545"	37°87'883"
5	A/zuria wereda	1170	06°59' 08"	37°29'117"
6	Benatsemay	1250	05°01' 00"	036°38'00"
7	Metehara	999	06°84'56"	036°00'35"
8	Shewarobit	1280	10°00'00"	39°53'41"
9	Meskan	1836	08°03'13"	038°29'10"
10	Kindo-koysha	1224	06°57'24"	37°31'11"

Collected data

All growth data and biomass data were collected at appropriate time. After 8 day sowing germination percent have been collected from all provenances. Similarly, the numbers of seedling in each provenance were counted after 2.5 month that used to calculate survival percent of provenance. Before the data were collected seedlings in each bed were sorted according to their vigor and 20 seedlings were tagged from each provenance, 10% of seedling for each species in single plot/seedling bed. Systematic random sampling technique was applied in each level of seedling to take 20 seedlings with in single plot. Heights and RCD Measurement using ruler and caliper and counting of branch number was done at the end of the experiment. Biomasses were measured using sensitive balance at the same time. Each was separated into aboveground biomass (leaves, buds and stems) and underground biomass (roots), and dried at 70°C for 48 h using an oven.

RESULTS AND DISCUSSION

Germination

The highest germination rate is recorded 79% and the lowest is 26.8% from Shewarobit and Konso respectively, which not the germination potential of *Moringa stenopetala*. This is may be as result of the higher altitude of the experimental site with respect to the growing range of *Moringa stenopetala*. The germination percent is very low with respect to Moringa stenopetala which requires about 25°C. In Burkinafaso, the provenance those have higher annual rainfall (1100 mm) relative to other provenance (500 mm) were law in germination rate Tamale (68%), Dedougou (78%). Appropriate agro ecology have contribution for the vigorously of the plant in terms of phenotypic growth like seed size that are known to differ with genetic background. Thus, a vigorous seed must possess key trait of rapid germination to establish seedlings across a wide range of environments. Shewarobit provenance significantly higher than Metahara, Meskan, A/zuria Wereda, Benatsemay and Konso and on the other hand, provenance Konso also significantly lowers. Except Konso and Benatsemay all other provenances have no significant difference among them. The present study is agree with done in Burkinafaso, the germination rate of *M. oleifera* have affected by provenance the provenance those from arid and semi-arid were have higher germination rate than other.

Survival

Moringa stenopetala declare significance difference among provenance on it survival percent presented below Figure 2. The highest survival percent is recorded on Humbo provenance and significantly lower is recorded by Konso, Benatsemay, Zuria wereda, meska and Metehara provenance (p value=0.05).

This may be Humbo provenance were have higher altitude (1484 a.s.l) than other Except meskan which found at 1823 a.s.l. in particular Metehara, Zuria-wereda, Benatsemay and Konso have lower altitude and lower survival rate. This result is agree with Edward, he found that provenance from arid and semi-arid area were more survive Gairo site, have arid environment. Similar result also stated in *Moringa oleifera* tree species.

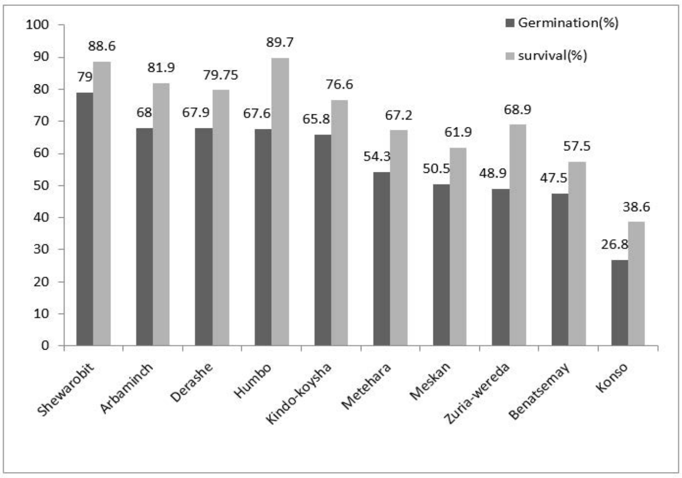

Figure 2: Germination and survival of different provenance of *Moringa stenopetala* species under nursery level at Meskan Wereda Gurage zone.

Morphological characteristics

Height growth: The height of *Moringa stenopetala* in this study detect significances difference (P=0.05) among provenances. Arbaminch, Derashe and Humbo are significantly higher than Benatsemay and Konso provenance and there is no significance difference with most of them. The differences in height growth within a site could be attributed to variations in adaptability among provenances while the between site differences in growth relate with altitudinal differences between Humbo have higher altitude than Konso and Benatsemay lower altitude with respect to the study site (Figure 3).

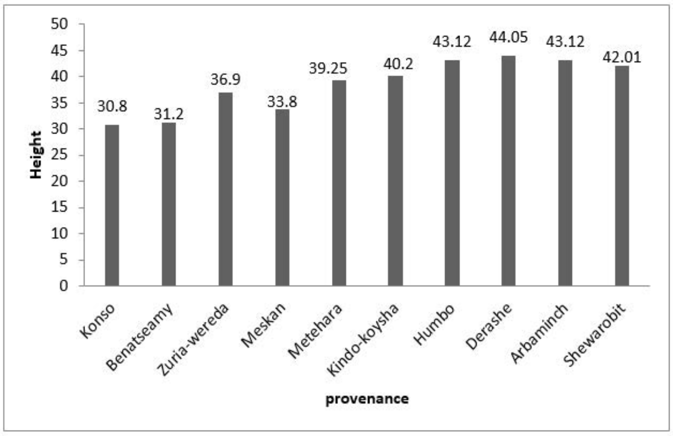

Figure 3: Height growth performance of provenance of *Moringa stenopetala* seedling at nursery level.

The study done on Tanzania on *Moringa oleifera* shows significantly difference in its height because of provenance difference. The mean height ranged between 2.66 m for Makhanga (Malawi) and 5.04 m for Maun (Botswana) at Gairo site and 4.82 m for Makhanga (Malawi) and 8.16 m for Maun (Botswana) at Ruvu site during the final assessment occasion (30 months after planting). Similar works done at Veitnam and Zimbabiwe were show provenance significantly affect the height growth of species.

Branch number

There was the significant difference among provenance due to branch number of *Moringa stenopetala* seedling at nursery level. Shewarobit provenance attains significantly higher branch number than Benatsemay provenance and no significance difference with the other. The provenance P1, P3, P9 and P11 had the high average number of branches per two week old seedling (6 branches), and have the significant difference when compared with P4, P5, P6 and P7. The highest number of branches of two months old trees was observed on the provenances P3, P4, P6, P8, P9 and P11 having 15 branches (Figure 4).

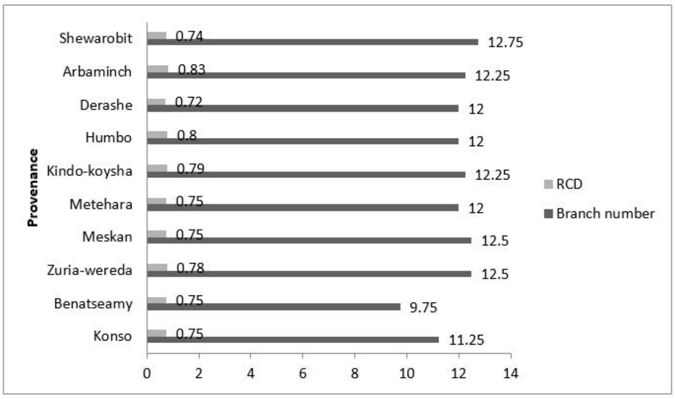

Figure 4: The growth performance of *Moringa stenopetala* provenance under nursery level at Meskan wereda Gurage zone, Ethiopia.

Root collar diameters

The provenance of *Moringa stenopetala* were not shows significant difference among them in their root collar diameters (P=0.05) as shown Figure 4 above. This ranges from 0.72 cm to 0.83 cm A/minch and derashe provenance respectively. In contradict to the present study the research done Tanzania shows that tree RCD for different *M. oleifera* Provenances differed significantly ($P<0.05$) in RCD at both sites in all months of assessment. RCD ranged between 5.36 cm for Mangochi (Malawi) and 8.91 cm for Mahalapye (Botswana) at Gairo site and 7.43 cm for PKM 3 (India) and 10.67 cm for Maun (Botswana) at Ruvu site during the final assessment occasion. Similar results have been observed in Zimbabwe on *Moringa oliefera* species.

Above and below ground biomass

Above and below ground biomass of *Moringa stenopetala* is significantly affected by provenance. In terms of Shoot Fresh Weight (SFW), Derashe provenance shows significantly higher than Metahara, A/zuria Wereda, Benatsemay and Konso and followed by Shewarobit and A/minch provenance. In Shoot Dry Weight (SDW) five provenances (Derashe, Humbo, Shewarobit, A/minch and Kindo-koysha) have attain higher over Metehara, Zuria-wereda, Konso and Benatsemay. This result is similar with the study done at Burkina faso on Khaya senegalensis A. Juss using four provenances, this study declare that the four provenances by their leaf, stem (Bopiel=0.27 g and

Koyenga=0.26 g) and in total biomass (Koyenga=12.1 g). Shewarobit and Arbaminch provenance have not significant difference from others except Metehara, which is significantly lower than others. Derashe, Kindo-Koysha and Shewarobit provenances are significantly higher, and Benatsemay and Metehara were significantly lower on their Root Fresh Weight (RFW). The Root Dry Weight (RDW) of *Moringa stenopetala* was affected by provenance. Derashe, Kindo-koysha and Shewarobite were significantly higher provenance and Konso, Zuria-wereda, Metehara and Benatsemay were significantly lower provenance.

The present study is agree with Ky-Dembele, who concluded that the root biomass of Khaya senegalensis A. Juss seedling significantly affected by provenance. According to Dao and Kabore, the above ground and below ground biomass of *Moringa stenopetala* were highly affected by province, which is similar report with current study. Similar work in Tanzania shows that there were significance difference b/n provenances by their biomass of *Moringa oliefera*. Other scholars founded that not only the biomass of *Moringa stenopetala* but also nutrient content also affected by provenance (Table 2).

Table 2: Above and below ground biomass of *Moringa stenopetala* under different provenances a nursery level at Gurage zone (gm).

provenance	n	Shoot fresh weight	Root fresh weight	Shoot dry weight	Root dry weight	S/R ratio
Shewarobit	4	19.58	16.8	6.54	5.43	1.18
Arbaminch	4	18.8	15.9	6.6	4.9	1.39
Derashe	4	21.03	16.6	6.9	5.35	1.27
Humbo	4	18.9	14.29	6.3	4.6	1.33
Kindo-koysha	4	19.1	16.5	6.3	5.2	1.15
Metehara	4	12.74	10.97	3.33	2.9	1.16
Meskan	4	16.9	13.02	5.6	4.2	1.33
Zuria-wereda	4	14.53	13.5	3.8	3.3	1.07
Benatsemay	4	14.1	11.4	3.11	2.4	1.25
Konso	4	14.3	12.3	3.6b	3.3	1.16
CV		15.6	14.2	17.19	16.5	17.07
MSD		6.4	4.8	2.16	1.6	NS

According to Dechasa Jiru identified that Gatto is the best accession as a whole by containing high N (%) and crude protein (%) and IVOMD (%). Moreover, it has a better organic matter (%). Similarly in Nigeria the study done by *Moringa oliefera* tree shows variation in nutrient content of leaf from different accession. In addition to this the study done at Aride Chaco of Arjentina on two cultivar of *Moringa oleifera* (Periyakalum-1 (PKM-1) which has been selected in India for start production during the first year, and their high yield, and an African accession from Tanzania of unknown selection pressure, but that were referred to as the African cultivar in that study) shows significantly difference in their oil (gm)/tree and Kg/hac (amino acid), pod/tree, and seed/tree production. One individual, E4-9, a PKM-1 plant, had significantly ($P<0.05$) higher production than all other plants. In addition, this individual was the highest extrapolated oil producer in both 2003 and 2004, with 595 and 564 kg ha^{-1}, respectively (ave. 580 kg ha^{-1}). Seed weight (200-seed wt.) was significantly greater in 2003 than 2004. Moreover, the research in Sierra Leone shows that the biomass of Gmelina arborea, Roxb have significant differences ($p<0.05$). Seeds obtained from the East (4 g) and South (3.87 g) at 2 MAP (month after planting) significantly differed with those obtained from the west (2.37 g). At 3 MAP seeds from the east also had the highest shoot dry weight (7.8 g) significantly different from seeds sourced from the west. At 2 MAP and 3 MAP, seeds obtained from the North, South and East regions were significantly ($p<0.05$) different in mean dry weight from seeds obtained from the Western area. Seeds obtained from the southern region had the highest mean dry weight (2.40 g) followed by seeds from the East (2.33 g) whilst seeds from the West had the lowest mean dry weight 1.4 g.

Effect of altitude on biomass of *Moringa stenopetala* seedling

The result show that there is a positive relation with altitude in this study, with the maximum altitude for this study was 1836 m.a.s.l. which is the optimum altitude for *Moringa stenopetala* production. Shoot fresh weight and shoot dry weight had shown better relation than root fresh weight and root dry weight. On the other hand shoot to root ratio of seedling have good correlation with altitude that means the altitude increase the shoot to root ratio of the different provenance were increase (Figure 5).

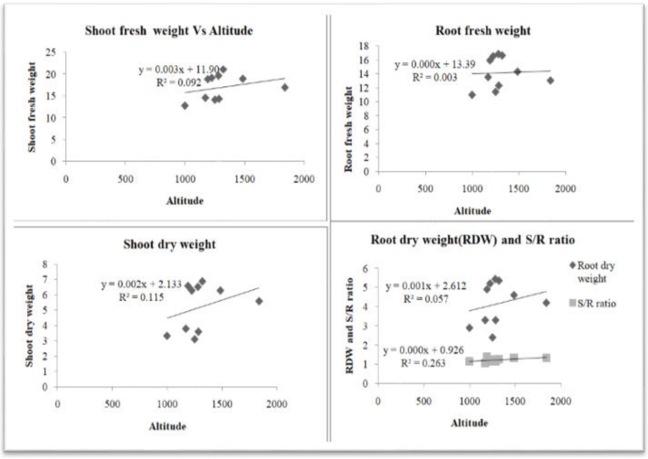

Figure 5: The correlation ship between altitude and fresh and dry form biomass of *Moringa stenopetala*.

CONCLUSION

According to the objective of this study all provenance except Konso, Benatsemay and Zuria Wereda are can used as seed source for production of *Moringa stenopetala* at Meskan Wereda of them Derashe and Humbo provenance are the best provenance. For production of more vigor *Moringa stenopetala* at nusery level Humbo, Derashe, Kindo-koysha, Shewarobite and Arbaminch provenance were recommended for seed source the study area (Meskan) of them Humbo is recommended as result of it is nearest to the study area.

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AUTHOR CONTRIBUTION

Begashaw mitku, had contribute in research by initiating the idea, writing and defending the proposal, field experiment management data collection and analysis and writing the manuscript. All the work starting to end managed by Begahsaw Mitiku. Fikiru Bafa, Managing the experiment at the field data collection. Getahun Yaekob, reviewing and editing the proposal and full manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. Nouman W, Siddiqui MT, Basra SM, Khan RA, Gull T, Olson ME, et al. Response of *Moringa oleifera* to saline conditions. Int J Agric Biol. 2012;14(5):757-762.
2. Nduwayezu JB, Chamshama SA, Mugasha AG, Ngaga YN, Khonga EB, Chabo RG. Comparisons in seed kernel sizes and early growth performance of different *Moringa oleifera* provenances in southeast of Botswana. Discov Innov. 2007;19(1):52-58.
3. Palada MC, Chang LC. Suggested cultural practices for Moringa. International Cooperators' Guide AVRDC. AVRDC pub. 2003(3):1-5.
4. Bischoff A, Vonlanthen B, Steinger T, Muller-Scharer H. Seed provenance matters effects on germination of four plant species used for ecological restoration. Basic Appl Ecol. 2006;7(4):347-359.
5. Gebregiorgis F, Negesse T, Nurfeta A. Feed intake and utilization in sheep fed graded levels of dried *Moringa (Moringa stenopetala)* leaf as a supplement to Rhodes grass hay. Trop Anim Health Prod. 2012;44(3):511-517.
6. Edward E, Chamshama SA, Mugasha AG. Growth performance of lesser known *Leucaena* species/provenances at Gairo inland plateau, Morogoro, Tanzania: research note. African For J. 2006;2006(208): 53-62.
7. Ejigu A, Asfaw A, Asfaw N, Licence P. *Moringa stenopetala* seed oil as a potential feedstock for biodiesel production in Ethiopia. Green Chem. 2010;12(2):316-20.
8. Yisehak K, Solomon M, Tadelle M. Contribution of *Moringa (Moringa stenopetala*, Bac.), a highly nutritious vegetable tree, for food security in south Ethiopia: a review. Asian J Appl Sci. 2011;4(5): 477-488.
9. Fuglie LJ. The Moringa Tree A local solution to malnutrition? The miracle tree: *Moringa oleifera*: Natural nutrition for the tropics. Nature's Pharm. 2003;221:22–35.
10. Abuye C, Urga K, Knapp H, Selmar D, Omwega AM, Imungi JK. A compositional study of *Moringa stenopetala* leaves. East Afr Med J. 2003;80(5):247-252.
11. Debebe M, Eyobel M. Determination of proximate and mineral compositions of *Moringa oleifera* and *Moringa stenopetala* leaves cultivated in Arbaminch Zuria and Konso, Ethiopia. African J Biotechnol. 2017;16(15):808-818.
12. Ibok O, Deborah O. Nutritional potential of two leafy vegetables: *Moringa oleifera and Ipomoea batatas leaves*. Sci Res Essays. 2008;3(2): 57-60.
13. Melesse A, Bulang M, Kluth H. Evaluating the nutritive values and *in vitro* degradability characteristics of leaves, seeds and seedpods from Moringa stenopetala. J Sci Food Agric. 2009;89(2):281-287.
14. Negesse T, Makkar HP, Becker K. Nutritive value of some non-conventional feed resources of Ethiopia determined by chemical analyses and an *in vitro gas method*. Anim Feed Sci Technol. 2009;154(4):204-217.
15. Azeez FA, Nosiru MO, Clement NA, Awodele DA, Ojo D, Arabomen O. Importance of *Moringa oleifera* tree to human livelihood: A case study of Isokan local government area in Osun state. Elixir Agric. 2013;55(2013):12959-12963.
16. Abay A, Birhane E, Taddesse T, Hadgu KM. *Moringa stenopetala* tree species improved selected soil properties and socio-economic benefits in Tigray, Northern Ethiopia. Arts Res J. 2015;4(2):68-78.
17. Demissie A, Bjornstad A. Phenotypic diversity of Ethiopian barleys in relation to geographical regions, altitudinal range, and agro ecological zones: as an aid to germplasm collection and conservation strategy. Hereditas. 1996;124(1):17-29.