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Morpho-sensory Evaluation of Orange Fleshed Sweet Potato (*Ipomoea batatas* L.) Varieties in the Low Lands of North Shewa Zone

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ABSTRACT

Background: Though sweet potato (*Ipomoea batatas* L.) is one of the internationally as well as nationally important root crops. Its production is challenged with various bottlenecks. Lack of planting materials, shortage of farmer preferred varieties, poor extension system among many other constraints. This study was conducted to assess the performance and test of different orange fleshed sweet potato varieties in participatory approach in the lowlands of North shewa.

Methods: Evaluation of eight varieties was carried out in main cropping season using a randomized complete block design with three replications. Number of roots per plant, root weight per plant, root length, root diameter, marketable and total root yield were measured and analyzed using the GLM procedure of SAS version 9.2. Moreover, farmers' perception assessment and sensory analysis which had an important constituency in the selection process were done using pairwise matrix and hedonic scale, respectively.

Result: Except root length, all the traits showed significant difference between varieties. Variety Kulfo gave the highest root yield (38.8 t ha^{-1}) and root diameter (98.8 mm); whereas the lowest root yield (22.1 t ha^{-1}) and root diameter (64.5 mm) were recorded from varieties Teo jet and Delvia, respectively. Farmers were also selecting varieties Lords, Cicilia and Birtukane. Panelists selected Bela, Birtukane and Kulfo as the best varieties. Hence, varieties Kulfo, Lords and Birtukane were recommended for further popularization to boost the production and productivity of the crop for production the lowlands of north shewa and other similar agro-ecologies.

Key words: Hedonic test, Orange fleshed, Participatory approach, Sensory evaluation, Yield.

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a dicotyledonous plant that belongs to family Convolvulaceae and order Polemoniales. It is an autopolyploid (2n=6×=90) crop with a basic chromosome number of 15. Its' large starchy and sweet tasting roots are an important edible part. It produces storage roots which are rich in carbohydrate, vitamins such as A, B complex, C, E and minerals such as potassium, calcium and iron (Shamil, 2021). The young leaves and shoots are sometimes eaten as green. Even though eating its leaf part at green stage is not accustomed in our country, it has high starch and protein content.

It is the third most important root and tuber crop after potato and cassava in the world (Laban *et al*., 2015). It can be grown in tropical, subtropical and frost-free temperate climatic conditions. In Ethiopia it is mostly cultivated in the southern, southwestern and eastern parts of the country and recognized as the third important crop next to Enset and Potato (Amare *et al*., 2014). The area covered and the quantity of sweet potato production is increasing from time to time (Amare *et al*., 2014) and in 2020/21 cropping season the total area under sweet potato in the country is 62116.56 ha with an average productivity of 25.74 t ha^{-1} (CSA, 2021), which is by far very lower than the potential yield is reported to be in the range of 40-50 t ha^{-1}.

Due to the low level of agricultural input requirement, high productivity per unit area, good nutritional value and increasing food demand owing to high population growth of the country, sweet potato is one of the ideal food security crop. Most sweet potatoes varieties currently grown by farmers are poorly adapted, have low root yields, less nutritive and white fleshed which have no beta carotene, a precursor to vitamin A. In plants, carotenoids including beta carotenes also act as a strong antioxidant, which prevents damage from various environmental stresses, including strong light, high temperature, UV and drought (Goo *et al.,* 2015). Moreover, the available improved orange flesh Sweet potato varieties were not evaluated for their adaptability and performance in North Shewa. Hence, evaluation of improved orange fleshed sweet potato varieties is sensible. Therefore, the objective of this study was to identify adaptable, high

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yielding and farm/consumer preferred orange fleshed sweet potato varieties.

MATERIALS AND METHODS

Description of the study area

The study was conducted under rain fed condition for two years (2019-2020) in the main cropping season at Kewet and Efratana gidim Woredas of North Shewa, Amhara National Regional State, Ethiopia. Soil of the testing areas represents a heavy clay-textured Nitosol. A detail of climatological and geographic descriptions of the study area are indicated below in Table 1 and Fig 1. Moreover, these areas are characterized by bimodal rainfall systems which mostly had an erratic or irregular distribution. Cereals like long maturing sorghum varieties and tef are the predominantly grown crops whereas cattle and shoats are the major livestock with natural pasture (grazing) and crop residues are the popular feed sources.

Description of test varieties

Experimental materials and field performance evaluation

Performance of eight released (*i.e. Kulfo, Belela, Birtukane*) and introduced (*i.e. Delvia, Jane, Tio joe, Cecilia* and *Lourdes*) varieties were evaluated for two seasons (2019 and 2020) in randomized complete block design (RCBD) with three replications under rain fed condition at Shewarobit and Ataye. The introduction was made from Mozambique through the national sweet potato improvement program at Hawassa Agricultural Research Center. Multiplication of planting materials was made at Ataye yemlowha kebele FTC. The experimental plots were prepared by a traditional oxen drawn plough. Undamaged, reasonably uniform stem cuttings with 2-4 buds and 15-30 cm were used as a planting material and were planted at the early onset of rainfall on in the last week of July in both years on well prepared plots in the ridge of 100 cm width with a 30 cm among plant. Each plot consisted four rows of 3 m long with a plot size of 3 m*4 m. Full dose of the NPS (100 kg/ha) fertilizer was applied at planting and the nitrogen fertilizer was applied in the form of Urea (100 kg/ha) was used (half at early stage of establishment and the rest after 45 days). All other agronomic operations (*i.e.* 2 times hand weeding and earthing up: at 20 and 45 days from planting) were performed uniformly. No pesticide was applied since there was no outbreak of insects or diseases and harvesting was done at full maturity manually using hoe.

Data were collected on yield and related attributes and combined analysis of variance (ANOVA) for yield and yield component characters of the varieties tested across

Table 1: Geographic and climatological descriptions of the study area.

Locations	Distance from A.A (km)	Altitude (m.a.s.l.)	Longitude	Latitude	Mean annual RF (mm)	Mean Temp. (°C)	
						Max	Min
Efratana gidim	270	1487	39°54′27″E	10°17′27″N	1018	27.7	11.5
Shewa robit	220	1298	39°53.47′E	9°59.7′N	750	34.20	9.62

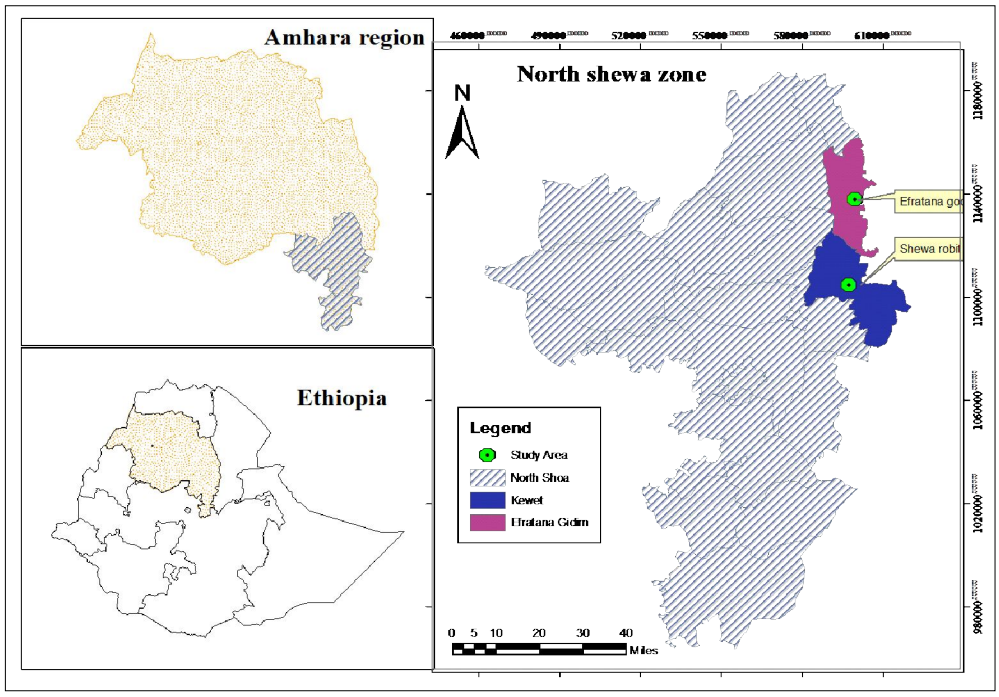

Fig 1: Map of the study area.

locations was performed using the SAS V-9.1 statistical package and the analysis was done at 5% significance level. The mean differences among treatments were calculated by using Duncan multiple range test (DMRT).

Farmers' field day and evaluation of the varieties

In 2020, Field-day was organized by inviting BoA experts and farmers from Shewa robit so as to facilitate future promotion works and acquire farers perception (*i.e.,* their selection criterions and varietal preferences). A total of 21 farmers and 10 (1 F) experts were participated during field evaluation. General awareness about the experiment was given for the selected farmers. Then, farmers were given the chance to discuss and share ideas on issues like their preferences, criteria for evaluation and characteristics of good sweet potato varieties.

All farmers were participated in both mass and individual selection of sweet potato varieties. Farmers were first identifying and list of attributes which was very important for them to select adapted varieties and gave weight for attributes according to their importance. The major selection attributes identified by farmers were yield, root size, above ground biomass, disease tolerance and number of roots. Finally, the varieties were evaluated by the farmers using these criterions and analyzed using pair wise and matrix ranking.

Sensory evaluation: samples preparations and evaluation

- **Sorting:** Disease free undamaged and more or less uniformly medium sized roots were selected and thoroughly washed with tape water.
- **Boiling:** The roots was immersed in tap water and boiled in a pressure cooker until the texture, as assessed by a knife, was considered tender and suitable for eating.
- **Sample preparation:** Samples were sliced into roughly equal sized pieces using a knife and coded with arbitrary numbers before served to selected panelists on plates as ready-to-eat food.
- **Selecting panelists:** 11 (7 M and 4 F) untrained panelists, who declared themselves as regular consumers of sweet potato were selected for sensory evaluation.
- **Serving and sensory assessment:** After each test, the panelists were asked to assess their appreciation of the color, taste, flavor, texture, mouth feel and over all acceptability using the 7-point hedonic scale (*i.e.*, from 1 ("dislike a lot") through 4 ("neither like nor dislike") to 7 ("like a lot") according to Tomlins *et al*. (2007).
- **Remark:** Panelists were provided with water to rinse their mouth before and after evaluating each sample to eliminate bias between evaluations.

RESULTS AND DISCUSSION

Agronomic performance of the varieties

A statistically significant ($p \leq 0.05$) difference was observed between genotypes in all agro-morphological traits (*i.e.* average root weight, average root number per plant, average root diameter, marketable root yield and total root yield) except average root length. Tesfaye *et al.* (2011), also reported significant variation between sweet potato genotypes in yield and other desirable traits in their adaptation trial in different agro ecologies of Ethiopia. The detail genotypic variations of these traits were discussed below in Table 2.

Though there is no statistically significant difference in root length ranged from 95.2 mm for Tio joe to 125.6 mm for Jane with mean root length of 114.4 mm. Maximum root diameter was recorded from variety kulfo (98.8 mm) with no significance difference with Tio joe (84.0 mm); whereas minimum root diameter was recorded on Delvia (64.5 mm) with no significant difference over Jane, lordes, Bela and Birtukane (Table 3). Average root number varied from 5.0 for Tio joe to 10.3 for Birtukane with no statistical variation with Lords (9.8) and Delvia (9.6). This weight difference may be come from genetic capability of the sweet potato varieties as also described by Nedunchezhiyan (2012). Marketable root weight ranged from 20.8 t ha^{-1} for Tio joe to 37.0 t ha^{-1} for Kulfo. As explained by Nedunchezhiyan (2007), the differences in marketable root yield could be attributed to the genetic variations among the orange fleshed sweet potato varieties in partitioning photosynthesis.

Table 2: ANOVA of mean square values of agro morphological traits of orange fleshed sweet potato varieties at Ataye and Shewarobit, 2019-20.

Source	DF	Mean square values of morphological traits of OFSP varieties					
		MRY (t ha^{-1})	TRY (t ha^{-1})	ARD (mm)	ARL (mm)	ARW (g)	ARNPP
loc	1	1063.1**	798.4**	23.7^{NS}	7330.1**	7885.1^{NS}	43.7*
rep (loc)	4	95.94^{NS}	109.0^{NS}	450.6^{NS}	2277.4^{NS}	9271.5^{NS}	1.3^{NS}
year	1	187.80^{NS}	87.1^{NS}	506.6^{NS}	812849.5**	388998.3**	608.0**
year*loc	1	43.30^{NS}	1.0^{NS}	10983.8**	5827.2*	86438.4**	319.0**
year*rep (loc)	4	78.75^{NS}	61.9^{NS}	370.9^{NS}	2224.1^{NS}	10091.5^{NS}	4.4^{NS}
treat	7	250.78*	275.0*	1399.3**	1437.1^{NS}	25792.0**	52.3**
loc*treat	7	234.97*	232.0*	637.3^{NS}	729.3^{NS}	12492.4*	3.4^{NS}
year*treat	7	239.09*	269.1*	969.4*	1328.5^{NS}	9106.5^{NS}	11.6^{NS}
year*loc*treat	7	183.51^{NS}	213.8*	364.6^{NS}	859.9^{NS}	13501.7*	28.2**

TRY: Total root yield, MRY: Marketable root yield, ARW: Average root weight, ARNPP: Average root number per plant, ARD: Average root diameter and ARL: Average root length.

Farmer preference of the varieties

Participation of farmers on technology evaluation would help in getting feedback about the technologies and identify existing constrain. Moreover, farmers' participation in the variety selection process has a paramount role to identify farmers' preferred traits and in promoting in promoting the technologies. In this regard, field day was prepared at full maturity/harvesting stage of the crop to select farmers preferred varieties and achieve the objective of the experiment participating researchers, experts, head of district agricultural development office, extension agents and farmers participated in the selection of varieties at Shewa robit in 2020.

Two phases of selection ways were used in the field day. The first was selecting a selection attribute to identify the best sweet potato variety. As illustrated in Table 4 farmers have set pest tolerance, yield, root size, root number and above ground biomass as the best attributes to identify the best sweet potato varieties. Then after, they have identified the varieties which they like most based on the allover mean of preset selection attributes (Table 5). Hence, Lords, Cicilia and Birtukane were selected as the best farmers preferred varieties.

Sensory evaluation of sweet potato varieties

Though the boiled form promotes the greatest losses in relation to chemical and nutritional composition of sweet potatoes, it is the widely used practice of consumption under Ethiopian condition. According to Kader (1985), sensory attributes such as appearance (visual), flavor (taste and smell), texture (feel), nutritive value and safety are very important criteria for assessing the quality of processed sweet potato roots. In this study, there is a notable difference among the tested sweet potato cultivars in terms of sensory attributes which in turn may significantly influence the overall taste and acceptability of the cultivars. With this notion, we have conducted sensory evaluation of boiled sweet potato varieties participating 11 panelists. The score of the sensory attributes of orange fleshed sweet potato varieties were ranged from 4 "neither like nor dislike" to 6 "like very much" (Table 6). The highest (6.1) and lowest (4.2) average acceptability is given for Bela and Lordes varieties, respectively. Generally, the panelists have disclosed as there is a significant varietal differences in terms of the overall sensory attributes. The preferences sensory attributes may

Table 3: Mean performance of yield and related traits of orange fleshed sweet potato varieties at Ataye and Shewa robit, 2019-20.

Genotypes	MRY	TRY	ARD (mm)	ARL (mm)	ARW (g)	ARNPP
Kulfo	37.0^{a}	38.8^{a}	98.8^{a}	100.3	197.0^{ab}	7.6^{bc}
Delvia	28.4^{bc}	30.8^{ab}	64.5^{c}	117.0	122.2^{c}	9.6^{ab}
Jane	29.3^{ab}	31.4^{ab}	70.4^{bc}	125.6	163.4^{bc}	7.4^{bc}
Tio joe	20.8^{c}	22.1^{c}	84.0^{ab}	95.2	163.4^{bc}	5.0^{d}
Cicilia	29.4^{ab}	30.6^{b}	81.5^{b}	119.7	234.1^{a}	5.9^{cd}
Lordes	33.2^{ab}	35.6^{ab}	68.5^{bc}	121.2	126.5^{c}	9.8^{a}
Bela	30.4^{ab}	31.3^{ab}	79.4^{bc}	114.3	225.7^{a}	5.4^{cd}
Birtukane	30.2^{ab}	32.5^{ab}	80.2^{bc}	122.4	116.6^{c}	10.3^{a}
Mean	29.8	31.6	78.4	114.4	168.6	7.6
LSD	7.8	7.9	16.4	25.4	58.8	2.2
CV (%)	32.3	30.8	25.6	27.1	42.6	34.7

TRY: Total root yield, MRY: Marketable root yield, ARW: Average root weight, ARNPP: Average root number per plant, ARD: Average root diameter and ARL: Average root length.

Table 4: Pair wise ranking matrix for the selection attributes of White and orange fleshed sweet potato varieties at Shewarobit, 2020.

Attributes	YD	RS	AGBM	PT	NR	Scores	Rank
Yield		YD	YD	PT	YD	3	2nd
Root size			RS	PT	RS	2	3rd
AGBM				PT	NR	0	5th
Pest tolerance					PT	4	1st
No. of roots						1	4th

NB: YD: Yield, RS: Root size, AGBM: Above ground biomass, PT: Pest tolerance and NR: Number of roots.

Table 5: Farmers preference ranking matrix summary sheet of orange fleshed sweet potato varieties at Shewa robit, 2020.

Variety	Farmers selection attributes					Mean	Rank
	PT	YD	RS	NR	AGBM		
Lordes	4	3	3	2.5	3.25	3.15	1st
Cicilia	3	2.42	2.92	2.25	3.17	2.75	2nd
Birtukane	1.5	3.25	3.17	3.75	1.67	2.67	3rd
Jane	1.58	1.08	1.5	1.58	1.92	1.53	4th

Table 6: Sensory attributes of boiled sweet potato varieties, 2020.

Genotypes	Color	Taste	Flavor	Texture	Mouth feel	Overall acceptability	Average	Rank
Kulfo	5.2	4.7	5.1	4.8	5.5	5.1	5.1	3
Delvia	4.8	5.2	5.0	5.1	4.9	5.0	5.0	4
Jane	4.4	4.2	4.8	4.6	4.0	4.4	4.4	7
Tio joe	5.4	4.7	4.5	3.9	4.1	4.5	4.5	6
Cicilia	5.2	4.6	4.6	4.9	4.5	4.9	4.8	5
Lordes	4.7	3.9	3.9	4.5	3.8	4.5	4.2	8
Bela	5.7	5.8	5.5	6.2	6.0	6.1	5.9	1
Birtukane	5.8	5.5	5.1	5.2	5.8	5.4	5.5	2
Mean	5.1	4.8	4.8	4.9	4.8	5.0		

vary from locations to locations and the sweetness level of sweet potato can influence the area of its utilization. Adu-Kwarteng *et al.,* (2001) reported that for products such as snack foods and desserts, the sweet taste is highly.

CONCLUSION AND RECOMMENDATION

Adaptation trial of eight orange fleshed sweet potato varieties were conducted in 2012-13 in the lowlands of north Shewa. Based the combined performance across locations and years, varieties Kulfo, Lords and Birtukane gave the highest root yield. Farmers were also selecting varieties Lords, Cicilia and Birtukane. Panelists selected Bela Birtukane and Kulfo as the best varieties. Hence, based on the current result we can suggest varieties Kulfo, Lords and Birtukane varieties which were selected both by farmers and researchers for production and popularization the lowlands of north shewa and other similar agro-ecologies.

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Conflict of interest: None.

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