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Adaptability and acceptability of new orange-fleshed sweetpotato varieties in selected areas of Eastern and Central zones of Tanzania

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Abstract. Orange-fleshed sweetpotato (OFSP) has been earmarked to be among food-based approaches in providing cheap source of beta-carotene a precursor of Vitamin A. Orange coloration intensity in sweetpotato roots correlates positively with the amount of beta-carotene available. In Tanzania, sweetpotato is produced almost entirely for home consumption and majority of popular varieties are either white or yellow- fleshed, which don't qualify to provide enough vitamins to meet the daily requirements. Majority of sweetpotato growers are resource poor with limited access to expensive sources of Vitamin A. Severe deficiency of Vitamin A has been reported to contribute to about 60 percent mortality rates for prescholers (children aged under 5 years) and pregnant/ lactating mothers in South Asia and sub Saharan Africa. In Tanzania, production and utilization of OFSP is limited, hence there was a need to test the adaptability and acceptability of the newly introduced varieties by farmers to ensure wide acceptance hence increased utilization. Twenty improved orange fleshed varieties introduced from CIP in 2001 were evaluated at Kibaha (lowland warm sub-humid) and Hombolo highland warm semi-arid) research stations. Two local checks were included. At harvest, farmers were invited to conduct the acceptability studies so as to capture the consumer-desired qualities. Varieties Tainung-65 (440215) and Japon Tresmesino (420009) produced significantlyhigh yields at both sites. Carrot-C (local check) gave the least yields. All varieties tested showed mild symptoms of virus disease. Results on farmer's assessment revealed that, among the varieties, Tainung-65, Jonathan, Zapallo and Centennial had generally higher acceptance levels. Others were rejected due to low dry matter, inability to produce enough planting materials especially during the dry season and some due to low yields. Varieties Tainung 65, Jonathan, Zapallo and Centenial have therefore been selected for on-farm testing.

Introduction

Sweetpotato (*Ipomoea batatas.* Lam) is grown throughout Tanzania and is the third most important root and tuber crop after cassava (*Manihot esculenta*) and round potato (*Solanum* spp.). The crop occupies approximately 14 percent of total arable land of the farms surveyed (Kapinga *et al.*, 1995). Consumption of sweetpotato is mostly by boiling; roasting and deep-frying of the roots and the leaves are blanched and used as vegetable.

Vitamin A deficiency (VAD) is the world's most common cause on child blindness (Mukherjee *et al., 2002*). WHO estimates 228 million children affected sub clinically and 500,000 children become partially/totally blind every year as a result of Vitamin A deficiency. Low *et al.* (2001) reported that, in Sub Saharan Africa (SSA) and Asia, there are severe deficiency of Vitamin A leading to high fatality

rates of 60 percent for preschoolers (children under 5 years of age) and pregnant/lactating mothers. In SSA, estimates of VAD children aged 5 range from 24% to 70% (Harvey and Taylor, 2003).

Promotion of the consumption rate of OFSP at community level is a food-based approach that aims at combating Vitamin A deficiency especially for women and children. Most of sweetpotato growers are resource poor, therefore consume imbalanced diets. Among Vitamin A rich foods, OFSP provides a cheap source of Vitamin A (Low *et al.,* 2001). Orange coloration intensity in sweetpotato root flesh indicates its level of β-carotene (van Jaarsveld, 2003).

Most of sweetpotatoes grown by farmers are white fleshed. Experience indicates that, most of the orange-fleshed sweetpotato varieties currently grown by farmers have low root yields accompanied by low dry matter contents (Mwanga *et al.,* 2003b). High dry matter content is among the major criteria used by farmers in the selection of sweetpotato varieties in Tanzania; especially in the Eastern zone farming communities (Masumba *et al.,* 2003). Therefore there was a need to introduce OFSP varieties adapted to Tanzania conditions and also acceptable to consumers.

Objectives. The following objectives were targeted:

- To introduce and evaluate orange-fleshed varieties.
- Assess consumer acceptability of the introduced orange fleshed varieties.
- Assess the adaptability of the introduced varieties in the two agro-ecologies (lowland warm sub humid and highland warm semi-arid areas).
- To increase the diversity of OFSP to combat Vitamin A deficiency at community level.

Materials and Methods

Tested varieties. Twenty OFSP varieties including the local checks namely Mayai and Carrot-C were used (Table 1).

Research locations. The varieties were evaluated on station for their general performance in terms of their virus reaction, root yield and adaptability. Two different agro-ecologies were identified and used for rapid evaluations of the introduced varieties. These were the lowland warm sub-humid (Kibaha), about 107 meters above sea level with sandy clay loam soils. It is characterized by a weak bimodal pattern of rainfall of an average of 970mm per annum. The second was a highland warm semi-arid (Hombolo) area about 1070 meters above sea level with reddish loamy soils. This area experiences a

Table 1: Twenty orange-fleshed varieties of sweet potato introduced from International Potato Center (CIP), Kenya in 2001.

Variety	CIP number
1. Tainung No. 65	440215
2. Tainung No. 64	440189
3. W-123	440018
4. W-151	440005
5. VSP-3	440287
6. VSP-4	440228
7. Jewel 38	56638
8. Jewel 31	440031
9. TIB	440060
10. Resisto	187017
11. Salyboro	187017
12. Excel	440016
13. BP-SP-2	440293
14. Kandee	440140
15. Zapallo	420027
16. Jonathan	420014
17. Julian	440141
18. CN 317	440090
19. Japon tresmesino	420009
20. Nemaneje	-
21. Centenial	440122

monomodal rainfall pattern with an average rainfall of about 655mm per annum.

Experimental design. A replicated preliminary yield trial was established during the long rains in April 2002 (Kibaha) and January 2003 (Hombolo). This is the common sweetpotato growing season in the respective areas. Plot size was 1.0m x 6.0m and plants spaced at 0.3m as intra-row spacing (i.e., 20 plants per ridge, two/four rows per variety).

Consumer acceptance by farmers. A total of 26 (Eastern zone) and 30 (Central zone) sweetpotato farmers were invited for participatory sweetpotato variety selection at Kibaha and Hombolo research stations, respectively. They were involved in the assessment of the post harvest attributes of the varieties including appearance, taste, mealyness, fibrousness and general acceptability. Clones were assessed by individual farmers using a subjective scale (1=very poor, 2=poor, 3=moderate, 4=good and 5=excellent) (Kapinga *et al.*, 2000). By the use of matrix ranking procedure mean scores were ranked. Farmer opinions on individual clones were computed into frequencies. Scores of the clones were compared using means.

Data collection and analysis. Data collected included plant establishment, virus scores, foliage and root yield (number, weight of the storage roots and dry matter content). A CIP scoring method was adopted and data subjected to the Analysis of Variance (ANOVA) using Mstat-C package.

Results and Discussions

Plant establishment and sweetpotato virus disease reaction. Generally establishment rates at Kibaha were higher with the average of 97.4 % as compared to Hombolo 75.5% (Table 2), probably as a result of semi arid condition the latter location experiences. At Kibaha all the varieties had good establishment rate of above 90.0% except for Julian (440141) (80.0%). The same variety Julian could not be established at Hombolo because it dried off after planting.

Reaction to sweetpotato virus diseases. Results on severity scores for sweetpotato virus disease ranged between class 2 (mild symptoms on a few plants) and 4 (mild symptoms on many plants, stunting of many plants). Generally, Salyboro and the two local checks (Carrot-C and Mayai) had the lowest scores displaying its mild resistance to the disease (Table 2). The rest of the introductions succumbed to the disease. Kibaha site was however less affected by SPVD than Hombolo. Virus pressure in the region, has slowed down the uptake and promotion of OFSP as noted earlier studies (Kapinga *et al.*, 1995; Kapinga *et al.*, 2003; Mwanga *et al.*, 2003a) and Laurie *et al.*, 2003). CIP however in collaboration with other research organizations has developed new varieties high in dry matter content and beta-carotene with good resistance to sweetpotato virus diseases. These varieties will be introduced in Tanzania soon (Kapinga *et al* 2003, Mwanga *et al* 2003b).

Plant vigour and foliage weight. Most of the varieties had intermediate vigour (class 3). Tainung 65 had the highest plant vigour (class 5 for Hombolo site) followed by the local checks Mayai and Carrot-C (Table 3). Hombolo site gave the lowest yields because of the dry weather as compared to Kibaha site. The amount of rain for the two cropping seasons at Kibaha was abnormally low and erratic.

Root yield and dry matter content. High root yields is among the best criteria that farmers base on in the selection of crop varieties. Average root yields that reported by the Tanzanian Ministry of Agriculture and Food Security are as low as 2.0 t/ha. In this study, at Kibaha site, almost 50% of the total introduced varieties produced higher yields than the local varieties (Table 4). Varieties Salyboro, Japon, Tresmesino, Tainung 65 and

Table 2: Plant establishment of orange fleshed sweet potato varieties and their reaction to virus diseases at Kibaha and Hombolo stations , Tanzania (2002/2003).

Variety/clone	CIP number	Plant establishment (%)		Sweetpotato virus disease evaluation	
		Kibaha	Hombolo	Kibaha	Hombolo
Tainung 64	440189	100.0	78.3	2	4
Jonathan	420014	97.5	76.3	4	4
Salyboro	187017-1	100.0	70.9	2	2
Centenial	440112	92.5	61.6	2	4
W-123	440018	-	73.4	3	4
W-151	440005	92.5		3	4
Zapallo	420027	92.5	79.1	2	4
Jewel 31	440031	100.0	84.0	3	4
VSP-4	440228	97.5	68.9	4	4
Nemanete	-	100.0	86.4	2	4
Kandee	440140	100.0	83.4	3	4
CN 317	440090	97.5	26.5	3	4
Tainung 65	440215	100.0	85.3	2	3
VSP-3	440287	97.5	72.5	4	4
TIB	440060	100.0	82.8	4	4
Jewel 38	56638	100.0	80.8	3	4
Resisto	440001	97.5	65.9	3	3
Excel	440016	100.0	81.0	2	4
Japon Tresmesino	420009	100.0	84.0	2	3
Julian	440141	80.0	-	2	-
Carrot-C	Local check	100.0	73.8	2	2
Mayai	Local check	100.0	95.0	2	2

SPVD scores: 1= No visible symptoms; 5= Completely attacked by virus.

VSP 65 gave higher yields at both sites. Majority of the tested varieties had high dry matter contents (beyond 30% at both sites). Varieties Tainung 64, Nemanete, W-123, CN-317 and Centenial although low yielders gave higher dry matter contents.

Consumer acceptability by farmers: A good number of varieties (55%) tested at both locations were highly accepted by consumers for good taste and other root attributes (Tables 5 and 6). Majority were appreciated for being "dry" as the local ones.

Conclusion and implications

The results showed that OFSP varieties were accepted at both trial sites in Tanzania indicating wide adaptability and acceptability. Varieties Salyboro, Tainung 65, Japon Tresmeniso, Jonathan, Zapallo, Excell and Kandee are doing well even in other parts of Tanzania, Kenya, South Africa, and Mozambique (Kulembeka *et al.*, 2003; Kapinga *et al.*, 2003; Laurie *et al.*, 2003). These have not been successful in the Lake Victoria Crescent of Uganda because of the high virus pressure (Mwanga *et al.*, 2003). This implies that careful recommendations should be made taking these exceptional cases into consideration. While research continues on breeding to combine multiple resistances to stress factors, most of the introduced varieties can be promoted in low virus pressures. Also breeding programs should target to raise populations using African landraces or improved African germplasm that are already adapted to various stresses. Examples are

Table 3: Plant vigour and foliage weights of the evaluated varieties of orange-fleshed varieties of sweet potato at Kibaha and Hombolo, Tanzania in 2002/3 and 2003/4.

Variety/clone	CIP number	Plant vigour		Foliage weight (t/ha)	
		Kibaha	Hombolo	Kibaha	Hombolo
Tainung 64	440189	3	3	7.7	5.1
Jonathan	420014	3	2	10.0	4.5
Salyboro	187017-1	3	3	11.7	5.0
Centenial	440112	3	1	9.3	1.2
W-123	440018	3	2	-	3.3
W-151	440005	3	—	12.0	-
Zapallo	420027	3	3	11.0	5.0
Jewel 31	440031	3	3	10.7	4.7
VSP-4	440228	3	3	13.0	4.8
Nemanete	-	2	3	6.0	5.5
Kandee	440140	3	2	4.3	3.1
CN 317	440090	2	1	6.7	1.3
Tainung 65	440215	3	5	15.3	5.2
VSP-3	440287	3	3	12.3	4.5
TIB	440060	3	3	6.0	1.9
Jewel 38	56638	3	2	4.0	2.5
Resisto	440001	2	3	3.0	2.0
Excel	440016	3	3	7.7	3.9
Japon Tresmesino	420009	3	3	14.0	4.6
Julian	440141	2	-	2.7	-
Carrot-C	Local check	3	4	9.0	6.1
Mayai	Local check	4	4	11.0	11.5
Mean				8.9	4.3
$LSD_{0.05}$					3.1

Vigourness: 1= Very poor; 5= Very vigour

successful programs in South Africa, Zambia and Uganda. The sweetpotato breeding and evaluation program in South Africa has been very effective. In South Africa 21 improved cultivars and lines, of which 14 were developed in South Africa, were found to be acceptable to resource-poor farmers and recommended for on-farm testing (Laurie *et al.,* 2003). In Uganda, variety Ejumula (a local landrace) and SPK 004 (an improved variety with an origin in Kenya) have widely been accepted by farmers and processors for their high yields and dry matter contents (Mwanga *et al.,* 2003b).

For this particular study all varieties selected for high root yields, dry matter contents plus consumer acceptance have been advanced in adaptability studies under diverse agro-ecologies. In these sites multiplication at primary sites have been initiated for the continuous supply of clean healthy planting materials.

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Table 4: Yield performance and dry matter contents of orange-fleshed sweet potato varieties at Kibaha and Hombolo sites, Tanzania (2002-2003).

Variety	CIP number	Root yield (t/ha)						Dry matter content (%)	
		Kibaha			Hombolo			Kibaha (2002)	Hombolo (2003)
		S	L	Total	S	L	Total		
Tainung 64	440189	1.0	7.7	8.7	0.6	2.0	2.6	27.3	35.3*
Jonathan	420014	1.0	10.0	11.0	0.2	1.1	1.3	30.6*	30.7*
Salyboro	187017-1	2.7	11.7	14.4**	1.8	4.0	5.8**	30.7*	30.7*
Centenial	440112	2.0	9.3	11.3**	0.1	0.5	0.6	30.6*	30.6*
W-123	440018	-	-	-	0.1	0.5	0.6	40.8*	40.2*
W-151	440005	3.3	12.0	15.3**	-	-	-		-
Zapallo	420027	2.0	11.0	13.0**	0.6	1.9	2.5	25.6	25.7
Jewel 31	440031	2,7	10.7	13.4**	0.8	1.0	1.8	30.5*	30.6*
VSP-4	440228	2.7	13.0	15.7**	0.3	1.6	1.9	28.7	28.6
Nemanete	-	2.0	6.0	8.0	0.4	0.8	1.2	37.5*	37.5*
Kandee	440140	4.7	4.3	9.0	0.6	1.1	1.7	30.7*	28.2
CN 317	440090	5.0	6.7	11.7**	0.3	0.7	1.0	28.2	30.7*
Tainung 65	440215	3.0	15.3	18.3**	0.8	7.8	8.6**	22.8	28.2
VSP-3	440287	3.0	12.3	15.3**	0.3	2.7	3.0**	28.0	28.2
TIB	440060	2.3	6.0	8.3	0.4	2.3	2.7**	30.6*	30.6*
Jewel 38	56638	1.0	4.0	5.0	1.0	2.3	3.3**	23.4	23.6
Resisto	440001	4.0	1.0	5.0	0.5	2.6	3.1**	27.5	27.5
Excel	440016	1.0	7.7	8.7	0.6	3.9	4.5**	42.2*	21.0
Japon Tresmesino	420009	1.7	14.0	15.7**	0.3	3.3	3.6**	27.6	27.5
Julian	440141	2.3	2.7	5.0	-	-	-	36.3*	-
Carrot-C	Local check	1.7	9.0	10.7	-	-	-	34.5*	-
Mayai	Local check	1.3	11.0	12.3*	0.6	0.9	1.5	36.6*	37.9*
Mean		2.4	8.80	11.2	0.5	2.1	2.6	31.0	
CV (%)					28.4	61.6			
$LSD_{0.05}$					1.0	1.9			

S- Small, L-Large * Selected for high dry matter contents** Selected for high yields.

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Table 5: Farmers assessment of cooked roots of OFSP varieties tested at Kibaha station, Tanzania (2002/03)

Variety	Scores				
	Appearance	Taste	Mealyness	Fibrousness	Overall acceptability
Excel	2.9	3	2.8	4.5	3.2
Jonathan *	3.4	3.3	2.7	3.7	3.7
Jewel *	3.4	3.4	2.8	3.8	3.7
Zapallo*	2.7	3.7	3.1	3.6	3.4
Centenial	3.3	3.4	2.8	3.5	3.2
VSP-4	3.1	2	2	3	2.4
Japon Tresmesino	2.5	3.1	2.5	3.2	3.2
Jewel 38	3.1	2.9	2.5	3.2	2.9
TIB*	2.9	3.3	3.2	3.3	3.3
CN 317	3	2.9	2.8	3.2	3.1
Kandee *	2.6	3.3	4.3	3.7	3.5
Nemanete*	2.9	3.4	3.1	3.7	3.3
Salyboro	2.4	2.2	1.9	2.6	2.3
Tainung 64	3.4	3	2.8	3.1	3.1
VSP 3	2.8	2.3	2	3.3	2.3
Resisto	3	3.4	2.8	3.3	3.1
W-151 *	3.6	3.7	3.4	3.5	3.6
Julian	3.4	2.8	2.5	3.3	3
Tainung 65*	3	3.4	3.3	3.8	3.5
Carrot-C (local)*	3.7	4.5	4.4	4.4	4.4
Mayai*	2.9	2.7	3.2	3.5	3.3

N= 26; Scores: 1= Very bad, 2= Bad, 3= Moderate, 4= Good, 5= Very good
*Selected varieties for further adaptability studies and on-farm evaluation and promotion

Table 6: Farmers' assessment of cooked roots of OFSP varieties tested at Hombolo Station, Central Tanzania (2002/3).

Variety	Scores				
	Appearance	Taste	Mealyness	Fibrousness	Overall acceptability
Excel	3.7	2.9	1.9	2.9	2.8
Jonathan*	3.9	3.9	3.1	4.3	3.8
Jewel	3.3	3.7	2.7	3	3
Zapallo *	3.9	3.7	3.1	4.4	3.6
Centenial*	3.9	3.8	3	3.8	3.8
VSP-4	3.6	3.1	2.8	3.7	3
Japon Tresmesino*	3.6	3.8	2.9	3.7	3.8
W-123*	3	3.4	2.7	3.9	3.3
Jewel 38	3.7	3.2	2.6	3.1	3
TIB*	3.5	3.8	3.1	3.2	3.3
CN 317	3.4	3.2	2.7	3.3	3.2
Kandee*	4.1	3.9	3.1	3.6	3.8
Nemanete	2.8	3.1	3.3	3.4	2.8
Salyboro	3.2	3.4	3.3	3.8	3.2
Tainung 64*	3.7	4	2.6	3.3	3.5
VSP 3*	4	4.1	3.2	4	3.9
Resisto	3.2	3.2	2.8	3.2	3
Tainung 65*	4.2	4.2	3.4	4.4	4.1
Mayai*	2.8	3.4	3.4	3.3	3.3

N= 30; Scores: 1 = Very bad, 2 = Bad, 3 = Moderate, 4 = Good, 5 = Very Good
*Selected varieties for further adaptability studies and on-farm evaluation and promotion

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