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High Starch, Low Sugar Yielding Genotypes of Sweet Potato and their Micropropagation

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ABSTRACT: *Sweet potato (Ipomoea batatas(L.)) is considered as the world's fifth most important food cum vegetable crop. Sweet potato tuber rich in starch, minerals and vitamins supplement food to small and marginal farmers in sweet potato growing countries. Central Tuber Crops Research Institute (CTCRI) at Bhubaneswar harbours a sizable collection of sweet potato germplasm. As it is vegetative propagated crop, the enhancement of genetic base is limited. In the course of the present study, genetic resources of sweet potato were screened for their high starch and low sugar content. Of the 116 different germplasm evaluated for yield, 14 genotypes showed high starch content. Among those 14 lines the five genotypes viz. ST-10, ST-13,ST-14, T-18, T-23 showed low sugar along with other attributes like high β-carotene in orange flesh lines like ST-14, T-23, high anthocyanin in purple flesh genotypes like ST-13, T-18 and high starch in white flesh genotype like ST-10 (21-25% starch). Micro propagation of these valued sweet potato was carried out using five different treatment media having various concentration of growth regulators. The influence of growth regulators was pronounced as well as genotypic influence was also observed. The bud break response period was found least in ST-13 and showed highest percentage of bud break and growth compared to the other genotypes in all treatment media. Results are encouraging for rapid multiplication, propagation and conservation of these high value crops.*

Key words*: Sweet potato, high starch, low sugar, micro propagation.*

INTRODUCTION

Sweet potato (*Ipomoea batatus* (L.) Lam.) belongs to the family *Convolvulaceae*. It ranks fifth most important food crop in the world. In India it is grown in an area of 0.14 m ha producing 1.17 million tones of tubers with productivity of 8.3 t/ha. It grows in most of the states including coastal states. Sweet potato tubers are used as subsidiary food after boiling, baking or frying. The tubers also form an industrial raw material for the production of starch, alcohol, pectin etc. The vines form an excellent source of green fodder for milch animals. Sweet potato has high nutritional value to supplement nutritional deficiency. The Central Tuber Crops Research Institute (CTCRI) of ICAR and its All India Coordinated Research Project (AICRP) centres are conserving more than nine thousands different tuber crops species including sweet potato. These are mostly conserved under *ex situ* in field and also *in vitro*. In the context of climate change and food security, conservation and evaluation for high valued traits of tropical tuber crops especially for short duration sweet potato is gaining importance in all tropical and sub-tropical countries including India. High starch, low sugar genotypes of sweet potato can be a reliable starch source to diabetics as they contain high nutritional attributes along with resistant starch which stabilizes blood sugar level. Hence research and development work at CTCRI and its Regional Centre is redirected to explore the potentials of sweet potato as high valued crops (Mukherjee 2013). The genotypes with valued traits like high starch, low sugar with other desirable agronomic traits can address the current issues of food-nutrition livelihood security (Mukherjee *et al* 2009 a & b). However sweet potato is

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propagated vegetatively through vine cuttings or tuber sprouts. Such system allows perpetuating pathogens affecting the quality of seed materials or propagules. Therefore, International and National laboratories now using *in vitro* propagation technologies to encounter the challenges of production of healthy planting materials.

At Regional Centre of CTCRI farm, stocks of 116 sweet potato genotypes were evaluated for high starch, low sugar and other attributes. The selected genotypes were subjected to propagate *in vitro*. Results of those studies are communicated here.

EXPERIMENTAL

The Screening of existing sweet potato germplasm for high starch, low sugar and other qualitative attributes were carried out in field and analyzed at Regional Centre laboratory. To study growth response of selected genotypes *in vitro* micropropagation was done in tissue culture laboratory of Regional Centre. *In vitro* culture was carried out by using nodal explants in MS media (Muarashige and Skoog, 1962) supplemented with different concentrations of growth regulators as given below. The sequence of culture, sub-culture were done following previous studies of Mukherjee, 2002 and Nair *et al.*, 1994.

- T1-MS
- T2 - MS + NAA (.5 mg/l) + BA (.5 mg/l)+GA3(2mg/l)
- T3 - MS + NAA (1 mg/l) + BA (.5 mg/l)+GA3(2mg/l)
- T4 - MS + NAA (.5 mg/l) + BA (1 mg/l)+GA3(2mg/l)
- T5 - MS + NAA (.5 mg/l) + BA (.5 mg/l)+GA3(4mg/l)

Dry matter, starch, sugar contents and other attributes like beta carotene, anthocyanin content were estimated using standard protocols (Moorthy *et al.*, 2010). Yield and other attributes were analyzed following standard statistical methods.

RESULTS & DISCUSSION

Evaluation of yield of 116 genotypes and assessment of starch, sugar and other desirable agronomic traits of selected genotypes as well as their response in *in vitro* are briefed under following sections.

Screening for high yield, high starch and low sugar

Of the 116 germplasm evaluated for yield, more than 16t/ha yield was recorded in 32 lines. The results on yield evaluation of present study are in line with the findings of Mukherjee *et al.*, (2009a). Of the 32 lines, 14 showed high starch (Table 1). Among these, five genotypes showed low sugar (<3%) along with other attributes (Table 2) like high beta carotene orange flesh (ST 14,T 23), high anthocyanin purple flesh (ST 13, T 18) along with high starch and ST 10 with high starch white flesh (Figs. 1-5). The results for beta- carotene & anthocyanin rich genotypes are in conformity with earlier findings of Mukherjee and Naskar 2012.

Table 1
The tuber yield & starch values of selected genotypes

Genotypes	*Tuber yield(t/ha)*	*% of starch*
S1-9	18.24	20.30
IGSP-10-6	22.89	18.90
IGSP-10-24	22.54	22.50
CO3-4-8	25.30	23.75
S1-11	23.30	18.20
IGSP-10-17	23.49	21.50
IGSP-10-22	22.87	21.90
CO3-4-9	24.75	20.10
IGSP-14-6	22.28	19.86
T 23	20.59	23.68
T 18	21.20	18.75
ST 10	23.52	21.00
ST 13	18.50	19.70
ST 14	19.80	19.50

Table 2
The starch & sugar values of selected genotypes

Genotypes	*% of starch*	*% of sugar*
ST10	21.8	2.1
STI3	20.34	2.34
ST14	19.93	2.49
T18	21.06	2.66
T23	22.06	2.9

MICRO PROPAGATION

In vitro micro-propagation techniques offer better option for rapid and mass propagation of plant material which can be achieved through axillary shoot proliferation (Mukherjee 1999).

In present study, different growth regulators with different concentrations were used to study the *in vitro* multiplication of sweet potato. The culture responses influenced by these factors were the days to bud break, percentage of explants response, shoots & roots produced per explants.

Of the different treatments, best results was obtained in T5 (GA_3 0.5 mg/l) followed by T2 (GA3 and BA 1mg/l, NAA 0.5 mg/l). Further, within the treatment the genotype ST-13 took less time for bud break than other genotypes (Table 3).

Table 3
Bud break response in selected genotypes

Genotypes	*Days taken for bud breaking by different genotypes in different treatment media*				
	T_1	T_2	T_3	T_4	T_5
ST-10	10-14	6-10	13-20	7-8	5-8
ST-13	9-10	5-8	11-18	6-10	4-5
ST-14	11-13	6-9	10-19	7-9	5-6
T-18	10-12	7-8	11-21	6-9	5-7
T-23	9-12	6-9	15-23	7-11	6-7

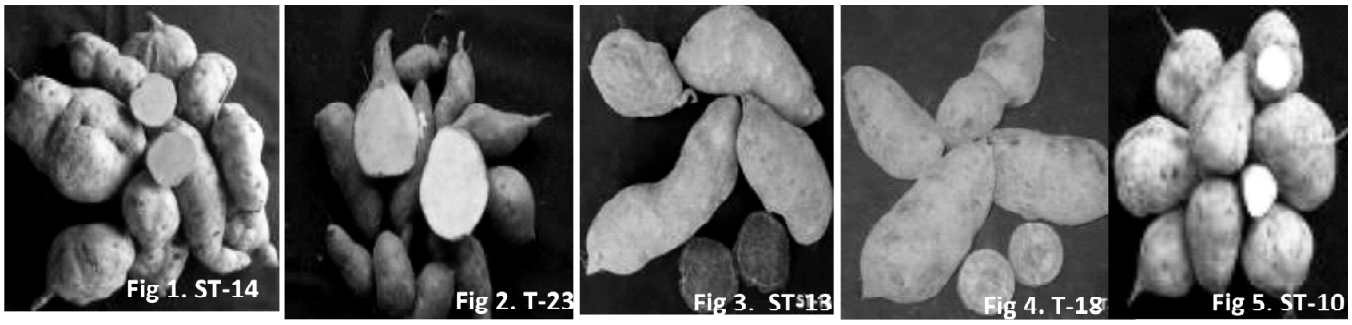
Under the different treatments, percentage explants response was highest in T5 followed by T2. The best explants response was obtained from the genotype ST 13 followed by T 18 (Fig. 6). Studies of *in vitro* culture of nodal explants in different culture media revealed different growth responses. The influence of genotypes and growth regulators are quite pronounced (Figs. 7-10). These results are in coherence with previous studies in sweet potato (Mukherjee 2002). Likewise, the growth response as mean number of shoots and roots was also observed to vary among the genotypes and also with the treatments within the genotypes. The response for mean number of shoots was maximum in T4 (treatment 4) followed by T5. Similarly, best response for mean number of roots was found in T3 followed by T5. Among the genotypes best response for shoot was recorded from ST 10 followed by T 23. On the other hand, best response for root was recorded in ST 14 followed by T 18 (Table 4). *In vitro* propagation found to be influenced by genotypes as explained earlier by Mukherjee, (2002). Genotypic influence can be minimized by manipulation of growth regulators & their doses.

CONCLUSIONS

The identified high starch low sugar genotypes in the present study can help as reliable source of carbohydrates for diabetics. High starch coupled with high beta-carotene & anthocyanin in ST-14 and ST-13 enhances nutritional values of those genotypes as functional food. *In vitro* growth responses of these high valued genotypes are encouraging for micro propagation, conservation and genetic enhancement of sweet potato.

Table 4
Growth response (in mean no.) of different genotypes in different media

Genotypes	T_1		T_2		T_3		T_4		T_5	
	Mean shoots	*Mean roots*	*Mean shoots*	*Mean roots*	*Mean shoots*	*Mean roots*	*Mean shoots*	*Mean roots*	*Mean shoots*	*Mean roots*
ST-10	1.02	1.04	1.45	1.36	1.01	1.89	2.94	1.2	1.88	1.54
ST-13	1.012	1.011	1.23	1.33	1.032	1.98	2.69	1.6	2.76	1.88
ST-14	1.98	1.032	1.39	1.27	1.012	2.87	2.66	1.56	1.95	1.49
T-18	1.07	1.20	1.23	1.44	1.033	2.64	2.54	1.63	2.77	1.73
T-23	1.033	1.33	1.43	1.35	1.041	1.93	2.88	1.47	2.49	1.84



Figures 1-5: Orange flesh (ST 14,T 23), high anthocyanin purple flesh (ST 13, T 18) along with high starch and white flesh ST 10

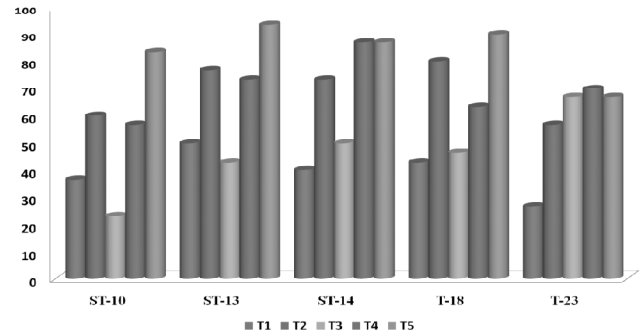


Figure 6: Percent explants response in different genotypes in different treatment

Figure 7: Growth of ST-10 in T5

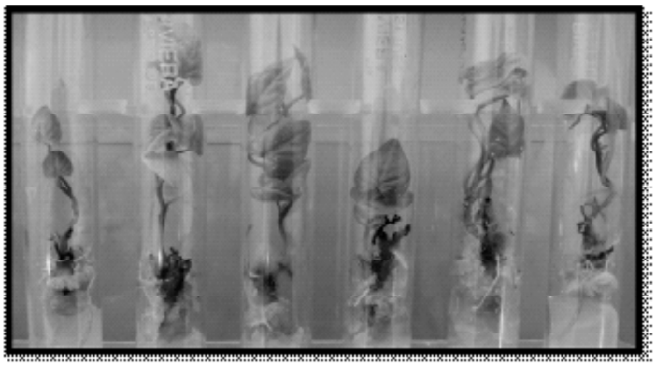


Figure 8: Growth of ST-14 in T5

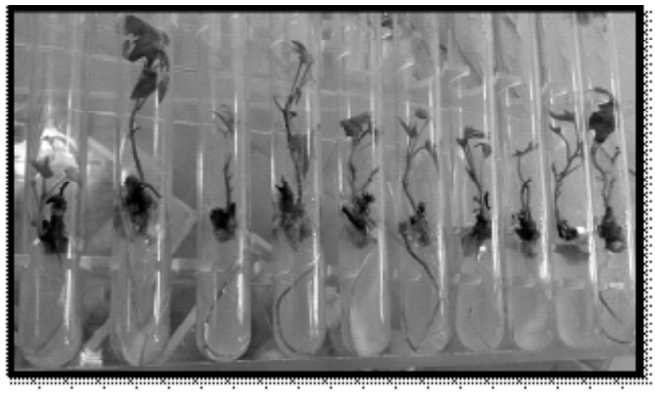


Figure 9: Growth of ST-13 in T5

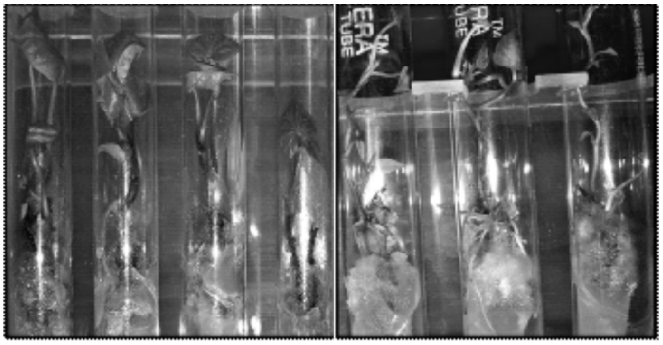


Figure 10: Growth of T-18 and T-23 in T5

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REFERENCES

Moorthy S. N., Naskar S.K., Shanavas S., Radhika G.S. and Mukherjee A. (2010), Physicochemical characterization of selected sweet potato cultivars and their starches. *International Journal of Food Properties*, 13: 1280-1289 I122 (7.4).

Mukherjee A (1999), Tuber Crops. In: *Biotechnology and its application in Horticulture*, Ed. (S P Ghosh), Narosa Publishing House, New Delhi, pp. 267-294.

Mukherjee, A. (2002), Effect of NaCl On *in vitro* propagation of sweet potato. *Applied Biochemistry and Biotechnology*, 102 : 431-441.

Mukherjee A, Naskar SK, Edison S (2009a), Salt tolerant biofortified orange and purple flesh sweet potato: coastal food and nutrition security, Technical Bulletin No. *51*, CTCRI, Thiruvananthapuram, Kerala, India, 36 pp.

Mukherjee, A., Naskar, S.K., Poddar, A., Dasgupta, M., Sahoo, M.R. and Chand, P.K. (2009b), Submergence and salinity tolerance in sweet potato (*Ipomoea batata* L.): progress and prospects. *Plant Sci. Res.* 31 (1&2): 1-9.

Mukherjee, A. And Naskar, S. K. (2013), Performance of orange and purple fleshed sweet potato genotypes in costal location of Odisha. Journal of Root Crops, Vol. 38 No. 1, PP. 26-31.

Murashige T, Skoog F (1962), A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiology of Plant* 15, 473-479.

Nair N G, Unnikrishnan M and Mukherjee A (1994), Advances in Horticulture. Vol. 8. Tuber Crops. Eds. K. L. Chadha and G. G. Nayar, MPH, New Delhi. pp 211-231.