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Comparative analysis of sugar content in storage roots of three sweet potato genotypes grown in a greenhouse under different substrate and irrigation conditions

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ABSTRACT
This study evaluated the biological sugar content in storage roots of three sweet potato genotypes derived from *in vitro* cultures and acclimatized under greenhouse conditions. The experiment was conducted at the National Institute of Research and Development for Potato and Sugar Beet (NIRDPSB) Brasov, using a 3×2×2 factorial design with three factors: genotype (CD/1, CD/3, CD/4), culture substrate [Pe (perlite) and T (peat–perlite mixture)], and irrigation regime (normal and controlled to induce water stress). Biological sugar content was determined using an automatic digital polarimeter. The results suggest that the highest storage root sugar content was obtained in the CD/4 genotype (12.07 °S) under water stress conditions, on a perlite (Pe) substrate. Under normal watering conditions, the highest sugar content values were obtained in the CD/3 and CD/1 genotypes, both on the T (9.47 °S and 9.30 °S) and Pe (8.83 °S and 6.80 °S) substrates. Overall, sugar accumulation in sweet potato storage roots was influenced by irrigation regime, substrate composition, and genotype.

Keywords - biological sugar content, culture substrate, irrigation regime, storage root, sweet potato

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I. INTRODUCTION

Ipomoea batatas (L.) Lam., commonly known as sweet potato and belonging to the family *Convolvulaceae*, is an important starchy root vegetable with a naturally sweet taste [1,2]. Originating in Central America, sweet potato is now widely cultivated worldwide, with approximately 92% of global production occurring in Asia and the Pacific Islands, of which 89% is grown in China [3–5]. Both tubers and shoots are consumed as staple foods in many countries. Yellow- and orange-fleshed varieties are rich in carotenoids, providing significant amounts of vitamins A and C [6,7].

Sweet potato's natural sugars are released gradually into the bloodstream, offering a sustained energy source without causing sharp blood sugar spikes or related fatigue and weight gain [8]. The total sugar content of several sweet potato varieties has been reported to be less than 12% on a dry weight basis, with glucose, fructose, and sucrose included in the calculation. Maltose is usually not considered, as it is absent in raw sweet potatoes [9].

II. MATERIAL AND METHODS

2.1. Biological material

Three sweet potato genotypes (CD/1, CD/3, and CD/4) were selected for this study and supplied by the Research and Development Station for Plant Culture on Sands (RDSPCS), Dabuleni. The acclimatization of these Korean sweet potato genotypes in Romania was successfully established in experimental plots at RDSPCS Dabuleni, Dolj County. The sweet potato genotypes used in this study (Table 1) are part of the *in vitro* conserved germplasm collection of the Plant Tissue Culture Research Laboratory within the National Institute of Research and Development for Potato and Sugar Beet (NIRDPSB), Brasov.

Table 1. Characterization of the sweet potato genotypes (Source: Project ADER 7.3.4., Phase 3)

Genotype	Flesh color	Dry matter (%)	Water (%)	Soluble dry matter (%)	Soluble carbohydrates (%)	Starch (%)	Vitamin C (mg/100 g f.w*)
CD/1	White	29.47	70.53	9.7	8.35	13.46	11.48
CD/3	Purple	34.43	65.57	10.2	8.77	12.69	14.08
CD/4	Yellow	36.20	63.80	9.9	8.52	13.36	14.96

*f.w – fresh weight

2.2. *In vitro* propagation

The establishment of *in vitro* cultures using axial shoot explants offers several advantages. The principles of these methods are well established and have been widely applied to various vegetable and horticultural species. Sweet potato shoot explants, obtained from plants grown under laboratory conditions, were aseptically inoculated onto culture medium inside a laminar airflow hood.

For the initiation of *in vitro* cultures, Murashige and Skoog (MS62) medium [10] supplemented with 40 g/L sucrose and solidified with 9.5 g/L agar was used. The pH of the medium was adjusted to 5.8 prior to autoclaving (Table 2). Sweet potato microcuttings were cultured under sterile conditions in single-use crystal-clear polypropylene vessels (dimensions: height: 80 mm, base: 125 mm L x 65 mm W, top and cover: 150 mm L x 90 mm W; green filter; Duchefa), which were hermetically sealed. Each vessel contained five microcuttings, approximately 2–3 cm in length, placed in the solidified culture medium. Cultures were incubated in a growth chamber for 6 weeks at 25–27°C, under a light intensity of 3000 lux, with a 16 h light/8 h dark photoperiod, under aseptic conditions.

Table 2. Culture media composition for *in vitro* growth of sweet potato

Media composition	**Quantity**	**Observation**
MS62 minerals and vitamins	4.40 g/L	
Naphthaleneacetic acid (NAA)	0.5 mg/L	
Gibberellic acid (GA_3)	0.02 mg/L	
Ascorbic acid	0.10 mg/L	
Calcium pantothenate	0.002 mg/L	pH 5.8
Calcium nitrate	0.10 mg/L	autoclaved at 120 ℃ for 20 min
L-arginine	0.10 mg/L	
Putrescine (HCl)	0.02 mg/L	
Sucrose	40.00 g/L	
Agar	9.50 g/L	
Plant Preservation Mixture (PPM)	3.00 ml/L	

2.3. *In vivo* acclimatization and cultivation

After six weeks of *in vitro* growth, sweet potato plantlets from the three genotypes were transferred to the greenhouse at NIRDPSB Brasov for the *in vivo* acclimatization phase (Fig. 1).

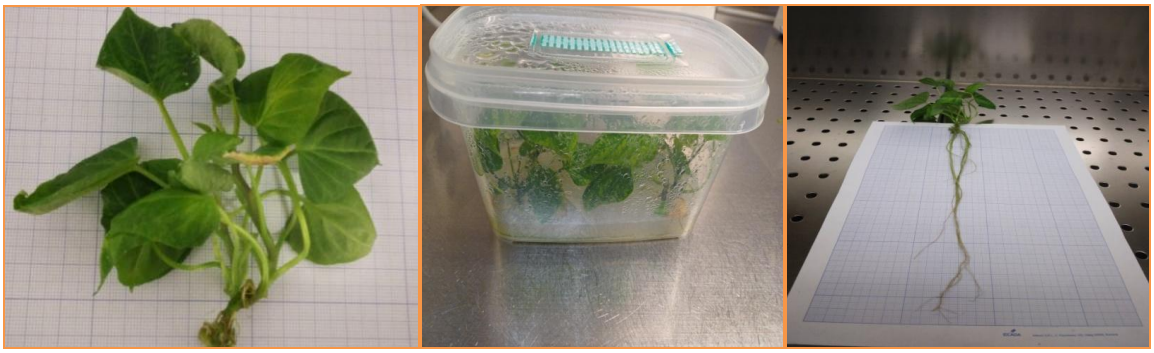

Figure 1. Appearance of sweet potato plantlets obtained *in vitro* before their acclimatization in a protected area

The plantlets were transplanted into pots placed in greenhouse using two different substrate types: perlite (Pe) and a mixture of red peat, black peat, and perlite (T) in a 2:1:1 volume ratio.

The sweet potato plantlets were transferred to the greenhouse on May 24. After an acclimatization period of one month, the plants were subjected to two irrigation treatments: normal watering (every 2 days) and water restriction (watering every 8 days) to induce water stress. Harvesting took place on October 20 (Fig. 2). Each tuber analyzed for biological sugar content weighed between 50 and 100 g.

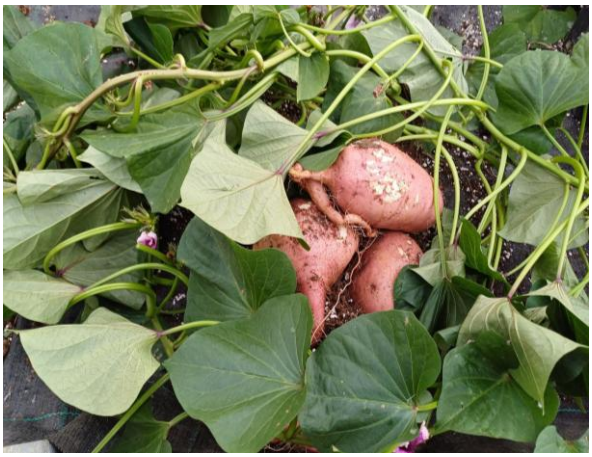

Figure 2. Sweet potato tubers and leaves at harvest (genotype CD/4)

2.4. Analysis of biological sugar content

The biological sugar content of fresh sweet potato storage roots was determined using the methodology for determining the biological sugar content of sugar beet roots. The sweet potato flesh was homogenized using a blender. 13 g of raw sweet potato paste were weighed and transferred into volumetric flasks, to which 5 ml of 80% ethanol was added. The volume was then brought up to 100 ml with distilled water and mixed thoroughly (Fig. 3). The sealed flasks were placed in a water bath at 80 °C for 20 minutes and then allowed to cool. 5–6 ml of lead acetate was added for clarification. The mixture containing the raw sweet potato paste was filtered through Whatman No. 4 filter paper. The filtrate was then introduced into an automatic digital polarimeter and the measured values were recorded. For each genotype, 12 samples were analyzed, depending on the culture substrate and irrigation treatment.

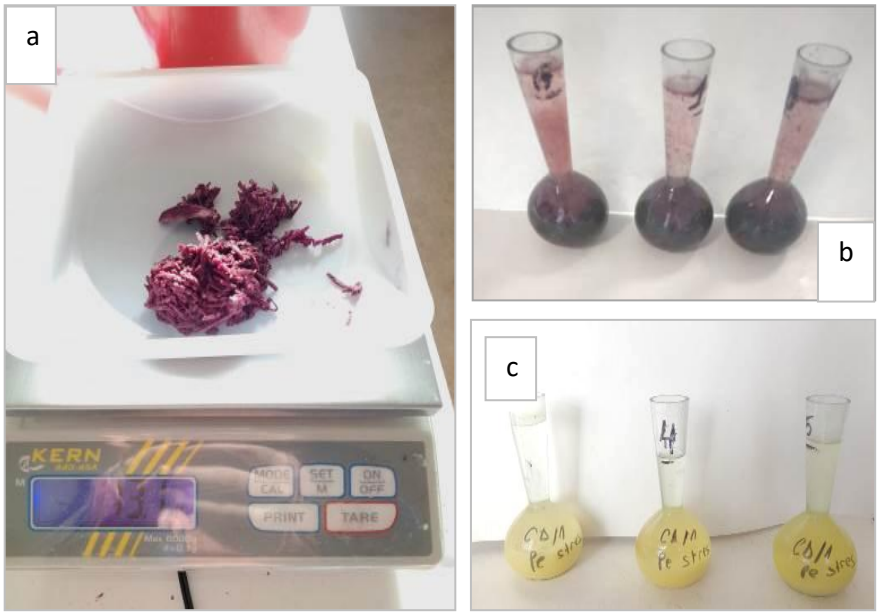

Figure 3. Weighing of sweet potato samples for biological sugar content analysis (a); sweet potato samples prepared for the filtration step (b and c)

III. RESULTS AND DISCUSSION

The sugar content varied depending on the genotype, the culture substrate, and the irrigation regime.

Applying a watering regime that induced water stress, with the peat–perlite mixture (T) as substrate, no significant differences were observed among the sweet potato genotypes in terms of sugar content (Table 3). Values ranged from 8.5 °S (CD/3) to 9.70 °S (CD/4) and 10.1 °S (CD/1). When perlite was used as the culture substrate, the highest sugar content was recorded in genotype CD/4 (12.07 °S), followed by genotype CD/3 (9.53 °S). The lowest sugar content was recorded in genotype CD/1 (7.17 °S), showing a highly significant decrease (-4.90 °S) compared to the control.

Table 3. Biological sugar content (°S) of sweet potato genotypes under water stress conditions using different culture substrates

Genotype	Culture substrate/ water stress	Av. (°S)	%	Diff. (°S)	Sign.
CD/4 (Ct)	T / water stress	9.70	100.0	0	-
CD/1	T / water stress	10.1	104.1	0.40	ns
CD/3	T / water stress	8.5	87.6	-1.20	ns
CD/4 (Ct)	Pe / water stress	12.07	100.0	0	-
CD/1	Pe / water stress	7.17	59.4	-4.90	ooo
CD/3	Pe / water stress	9.53	79.0	-2.53	o

DL 5%= 1.83 °S; 1%= 2.53 °S; 0.1%=3.53 °S

Under normal watering, compared to the control, sweet potato genotypes differed significantly in storage root sugar content, both on the T substrate (peat–perlite mixture) and on the Pe substrate (perlite only) (Table 4). The highest sugar content was recorded in the CD/3 genotype, both on the T substrate (9.47 °S) and on the Pe substrate (8.83 °S), the differences compared to the control being very significant (3.80 °S and 5.10 °S respectively). The CD/1 genotype also exceeded the control with a distinctly significant difference

on the Pe substrate (3.07 °S) and very significant on the T substrate (3.63 °S).

Table 4. Biological sugar content (°S) of sweet potato genotypes under normal watering conditions using different culture substrates

Genotype	Culture substrate/ normal watering	Av. (°S)	%	Diff. (°S)	Sign.
CD/4 (Ct)	T / normal watering	5.67	100.0	0	-
CD/1	T / normal watering	9.30	164.1	3.63	***
CD/3	T / normal watering	9.47	167.1	3.80	***
CD/4 (Ct)	Pe / normal watering	3.73	100.0	0	-
CD/1	Pe / normal watering	6.80	182.1	3.07	**
CD/3	Pe / normal watering	8.83	236.6	5.10	***

DL 5%= 1.83 °S; 1%= 2.53 °S; 0.1%=3.53 °S

IV. CONCLUSIONS

Three sweet potato genotypes with different flesh colors were used in this study: CD/1 (white), CD/3 (purple) and CD/4 (yellow). Sweet potato microplants grown *in vitro* were used to initiate this research. They were then acclimatized and grown in a greenhouse from May to October. Two types of substrate (T and Pe) were used and two watering regimes (a normal watering regime and one with water restriction) were applied.

The biological sugar content of fresh storage roots varied in the three sweet potato genotypes, under the influence of the growing conditions. The results obtained in this study suggest that the highest biological sugar content was obtained in the CD/4 genotype (12.07 °S), under water stress conditions, on a perlite (Pe) substrate. Under normal watering conditions, the highest sugar content values were obtained in the CD/3 and CD/1 genotypes, both on the T (9.47 °S and 9.30 °S) and Pe (8.83 °S and 6.80 °S) substrates.

Sugar content and sweetness are essential indicators of taste evaluation in sweet potato and critical factors affecting consumer acceptability [11]. High-sugar cultivars are particularly suitable for products such as baked goods and beverages. Their natural sweetness may reduce the need for added sugars in processed foods. The desirability of high- versus low-sugar cultivars depends on cultural preferences, intended use, and consumer health considerations.

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