

Short Communication

An efficient protocol for *in vitro* clonal propagation of natural sweetener plant (*Stevia rebaudiana* Bertoni)

Ashish Ojha^{1*}, V. N. Sharma¹ and Vinay Sharma²

¹Department of Biotechnology, Plant Tissue Culture and Research Development Laboratory, MIET group of Institutions, Meerut- 250005, U. P. India.

²Department of Biotechnology and Bioscience, Banasthali University, Banasthali, Rajasthan, India.

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Leaf segments of *Stevia* were cultured on MS medium supplemented with varying concentrations (0.5, 1.0, 1.5, 2.0, 2.5 mg/L⁻¹) of growth regulators (BAP and 2, 4-D). Ninety one percent aseptic cultures were obtained when sterilized with 0.1% HgCl₂ for 10 min. The highest amount of callus was obtained in MS medium supplemented with 1.0 mg/L⁻¹ BAP+0.5 mg/L⁻¹ 2, 4-D, respectively. On the other hand, 2.5 mg/L⁻¹ BAP + 0.5 2,4-D showed lowest performance. Highest shoot was obtained in 2.0 mg/L⁻¹ BAP. These shoots were transferred into different concentration of IBA, NAA and IAA (0.5, 1.0, 1.5, and 2.0) used. Highest rooting percentage was recorded on MS medium with 0.5 mg/L⁻¹ IAA. The rooted plantlets were transferred into mist chamber with relative humidity for 2 - 4 week after these plants were hardened and successfully established in soil.

Key words: *Stevia rebaudiana*, Sweetener, Callus, leaf.

INTRODUCTION

Stevia (*Stevia rebaudiana* Bert.) is a small, herbaceous, semi-bushy, perennial shrub of Compositae family originated from Paraguay. It grows well at the temperature ranging between 15 - 30°C. It is one of 154 members of the genus *Stevia*, which produces stevioside, a diterpenoid glycoside isolated from plant leaves (Robinson, 1930). Stevioside of special interest to diabetics, persons with hyperglycemia and the diet conscious. A sugar-free, no calorie natural sweetener is especially helpful for people who are diabetic, prone to yeast infections, or trying to lose a few extra pounds by controlling calories. The product can be added to tea and coffee, cooked or baked goods, processed foods and beverages. Dry leaves of this plant are 30 times sweeter than sugar with Zero calories. The first report of commercial cultivation in Paraguay were in 1964 (Sumida, 1968) began a large effort aimed at establishment. *Stevia* as a crop in Japan, since then *Stevia* has been introduced as a crop in a number of countries including Brazil, Korea, Mexico, U.S. and Canada (Lee et al., 1979). The herbal drug industry is considered to be a high growth industry of the late 90s and

seeing the growing demand, it is all set to flourish in the next century in ancient Indian traditional Ayurvedic system of medicine.

Stevia has various properties such as antibacterial, anticandidal, antifungal, antiviral, cardio tonic (tones, balances, strengthens the heart), diuretic, hypoglycemic, vasodilator. Seed germination of *Stevia* is often poor or very low (Miyazaki and Watanabe, 1974).

Therefore, there are basically two options for multiplication. The first is tissue culture and second is vegetative propagation.

MATERIALS AND METHODS

Plant materials

The explants; leaf segments were used as experimental material. The explants were collected from 5 - 6 months old field grown plants at FRI (Forest Research Institute, Dehradun) experimental field. The explants were treated with Tween 20 (fungicide) 5 - 6 drops for 5 min with constant shaking for clean fungus content from leaf surface then washed thoroughly with distilled water. Then the materials were taken under laminar air flow cabinet and surface sterilization was done with (0.1% HgCl₂) mercuric chloride for 10 min followed by 4 - 5 times rinse with sterile distilled water to remove traces of HgCl₂ from material.

*Corresponding author. E-mail: ashish_ojha1087@rediffmail.com. Tel: 09808435371.

Table 1. Effects of cytokinin and auxin in MS medium on *in vitro* shooting and callus formation from leaf segments of *Stevia*.

Growth regulators (mg/L ⁻¹)	% of shoot	Shoots /Cultures	Average shoot length (cm)	Texture
BAP (0.5)	45.67	3.13 ± 0.11	2.15 ± 0.28	Green
BAP (1.0)	56.31	4.33 ± 0.29	2.32 ± 0.27	Green
BAP (1.5)	60.10	5.40 ± 0.18	2.43 ± 0.11	Green
BAP (2.0)	76.44	6.78 ± 0.23	3.34 ± 0.55	Green
BAP (2.5)	58.27	5.12 ± 0.41	2.00 ± 0.42	Green
		Amount of callus		Callus status
BAP + 2-4-D (0.5)+ (0.5)		++++		Good
BAP + 2-4-D (1.0) + (0.5)		+++++++		Best
BAP + 2-4-D (1.5) + (0.5)		++++		Good
BAP + 2-4-D (2.0) + (0.5)		+++		Average
BAP + 2-4-D (2.5) + (0.5)		+		Dead

Preparation of culture media

Stock solution of all components were prepared with appropriate amount of all the components, Appropriate amount of all stock solution were mixed following the standard media preparation procedure. The pH of the media was adjusted to 5.6 - 5.8 and growth regulators were added at different concentration (0.5, 1.0, 1.5, 2.0, 2.5 mg/L⁻¹). In Each treatment 2 explants were inoculated in 50 test tubes, 10 test tubes each.

Inoculation technique

Leaf segments into 1 cm² square pieces and the aseptically inoculated onto callus induction media. All inoculation and aseptic manipulation were carried out in laminar air flow cabinet. Before use, the floor of cabinet was cleaned with 90% ethyl alcohol to reduce chance of contamination. The instruments like scalpels, forceps, needles etc, were sterilized by an alcoholic dip and flaming method inside the laminar air flow chamber. Before the inoculation hands were cleaned by spraying 70% ethyl alcohol. After the inoculation tubes were shelved in dark condition. The temperature of the culture room was maintained at 25 ± 1°C.

Data collection

From the seventh day of inoculation, regular visual observation was done up to five weeks to records the days of callus initiation and maturation. The explants showing embryogenic callus was recorded after 4 - 5 weeks, Histological sections and microscopic observation was done under microphotograph.

RESULT AND DISCUSSION

In vitro shoot proliferation and multiplication

The auxiliary buds in callus zones proliferated within 6 - 7 weeks of culture on cytokinin supplemented MS medium. When the explants were cultured on 2 mg/L⁻¹ BAP containing media (76.44%) of them produced shoots. the auxiliary shoots proliferated and elongated (3.34 ± 0.55 cm) within three weeks of culture. In the experiment MS

medium containing 2 mg/L⁻¹ BAP showed the best response of multiplication (Uddin et al., 2006). Shoot formation with 6.78 ± 0.23 microshoots per explants (Table 1). Further more, MS medium containing 0.5 mg/L⁻¹ 2,4-D +1.0 mg/L⁻¹ BAP also showed the maximum callusing in leaf segment explants (Table 1).

Rooting induction from microshoots

In vitro raised microshoots (3-4 cm) were excised from callus culture and grown on MS medium with growth regulators. Initiation of roots from microshoots was very slow in NAA. The percentage of shoots that formed roots and no of roots/ shoots significantly varied at different concentration of IBA, IAA and NAA.

The highest rooting 98.12% in microshoots was obtained as MS medium containing 0.5 mg/L⁻¹ IAA with 3% sucrose with in 2 weeks of microshoot transfer (Table 2). Further more the no of roots per microshoots was optimal (13.7 Roots/ Microshoots) on MS medium containing (0.5 mg/L⁻¹ IAA) but the average root length per shoot was higher (3.65 cm) on 1.5 mg/L⁻¹ IBA containing MS media (Murashige and Skoog, 1962).

The effect of IBA, IAA and NAA on root induction was positive; however, auxins concentrations had a positive effect on the number of roots/ shoots and it was higher in the case of IAA than IBA and NAA. Steven et al. (1992) reported that 1.0 mg/L⁻¹ NAA MS medium showed maximum rooting in propagated shoots of *Stevia*. The potential of IBA in root induction has been reported in many species (Epstein et al., 1993). In root induction experiment, 0.5 mg/L⁻¹ IAA was found better as maximum roots proliferated that result as better reported by Steven et al. (1992).

Acclimatization and field establishment

Rooted plantlets were shifted to plastic pots containing

Table 2. Effects of IBA, NAA or IAA on adventitious root formation from micro cuttings in *S. rebaudiana*.

Auxins types	Concentration (mg/l)	% of cuttings rooted	No. of roots per shoots	Average root length (cm)	Day of murgence of roots (days)
IAA	0.5	98.12	13.71	2.10	6-12
	1.0	91.40	9.88	2.35	6-14
	1.5	74.99	7.31	2.17	6-12
	2.0	64.31	4.98	3.01	6-17
NAA	0.5	81.50	8.65	2.41	6-12
	1.0	70.20	7.57	2.93	6-12
	1.5	59.72	5.34	2.42	6-12
	2.0	54.43	4.45	2.78	6-12
IBA	0.5	68.72	7.88	3.07	6-14
	1.0	60.68	5.95	3.43	6-14
	1.5	51.85	5.02	3.65	6-14
	2.0	40.43	3.55	2.98	6-12

sterilized soil, sand and peat moss at 1:1:1 ratio covered with transparent polythene begs and placed in acclimatization room at 28°C with 70 - 90% humidity. After the 2 weeks and than completely removed of after 3 weeks for proper hardening. A total no of 71% plants of survived thoroughly this procedure. In many species the reduced the survival rate of the explants during acclimatization is affiliated to the utilization of high concentration of IBA and NAA in rooting medium (Al-maarrie et al. 1994).

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REFERENCES

- Al-Maarrie K, Arnaud Y, Miginiac E (1994). Micropropagation of *Pyrus communis* cultivar, *Passe crassane* seedlings and cultivar. Williams: factors affecting root formation *in vitro* and *ex-vitro*. Sci. Hortic. Amsterdam. 58:207-214.
- Epstein E, Sagee O, Zahir A (1993). Uptake and metabolism of Indole-3 acetic acid and Indole-3 butyric acid by *Petunia* cell suspension culture, Plant. Growth Regul., 13:31-40.

- Lee JI, Kang KK, Lee EU (1979). Studies on new sweetening resource plant *Stevia (Stevia rebaudiana Bert.)* in Koprea. I. Effect of transplanting date shifting by cutting and seeding dates on agronomic characteristics and dry leaf of *Stevia* (English abstr.) Res. Rep. ORD., 21:171-179.
- Miyazaki Y, Watenable H (1974). Studies on the cultivation of *Stevia rebaudiana* Bertoni; on the propagation of the plant (English abstr.). Jap. J. Trop. Agric., 17:154-157.
- Murashige T, Skoog F (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures, *Physiol. Plant*, 15:473-497.
- Robinson BL (1930). Contributions from the Grey Herbarium of Harvard University. The Grey Herbarium of Harvard University, Cambridge.
- Steven MS, Gail BM, Christopher WWB (1992). Stevioside biosynthesis by callus, root, shoot, and riited-shoot cultures *in-vitro*, *Plant. Cell, Tiss. Org.*, 28:151-158.
- Sumida T (1968). Reports on *Stevia* introduced from Brazil as a new sweetness resource in Japan (English summary). *J. Cent. Agric. Exp. Stn.*, 31:1-71.
- Uddin MS, Chowdhury MSH, Khan MMH, Belal Uddin M, Ahmed R, Baten MA (2006). *In vitro* propagation of *Stevia rebaudiana Bert* in Bangladesh, *Afr. J. Biotechnol.*, 5(13): 1238-1240.