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Response Of *Cattleya* Orchid Subculture Growth with Various Types and Concentrations of Sweet Potato (*Ipomoea batatas* L.) Extracts

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Abstract

Cattleya orchid is a large-flowered ornamental plant known for its vibrant color and pleasant fragrance. The challenges of conventional propagation and high market demand have prompted the use of *in vitro* techniques. The success of *in vitro* propagation is highly influenced by the culture medium, which can be enriched with organic sources such as sweet potato extract, a rich source of vitamins and carbohydrates. This study aims to evaluate the effect of different types and concentrations of sweet potato extract on the growth of *Cattleya* orchid subcultures. This experiment used a Randomized Block Design (RBD) with two factors: sweet potato types (white, yellow, purple) and extract concentrations (50, 100, 150, and 200 $g \cdot L^{-1}$), analyzed using ANOVA and Duncan's Multiple Range Test at 5% significance level. The results showed that the purple sweet potato yielded the highest explant height increase (0,90 cm), while the interaction of white sweet potato with 50 $g \cdot L^{-1}$ extract concentration produced the highest leaf number (1.77 leaves). The addition of sweet potato extract supports the *in vitro* growth of *Cattleya* orchid subcultures.

***Keywords**: Cattleya, orchid, in vitro, sweet potato extracts, growth, subculture*

INTRODUCTION

Orchids, belonging to the family *Orchidaceae*, are highly popular ornamental plants. Their appeal lies in the diversity of their shapes and the attractiveness of their flower colors. However, orchid production has declined over the past three years in both cut orchids and potted orchid categorires. For potted orchids, total production was at 3.999.203 plants in 2021, dropped to 3.952.996 in 2022, and continued to decrease to 3.785.454 plants by 2023 (Badan Pusat Statistik, 2024). *Catteya* is one of the orchid genera with high market demand (Rohman *et al*., 2023).

Conventional cultivation of *Cattleya* orchids is challengin because their seeds lacks food reserves. The endosperm in orchid seeds is unable to supply the necessary nutrients for embryo growth during the germination process. Although germination can occur, *Cattleya* orchids require a long time to reach the flowering phase. Therefore, *in vitro* propagation is considered an effective approach in increasing the production of *Cattleya* orchids.

The *in vitro* propagation technique, or tissue culture, is a method to produce plant seeds through isolation of plant parts into sterile media. This method is capable of producing a large number of seedlings in a relatively short period, and the resulting seedlings possess genetic characteristics identical to those of the parent plant. The success of tissue culture is strongly influenced by the media used, which must contains essential nutrients to support explants growth. Nutrients in the media can be obtained from organic materials such as fruits and vegetables that are rich in vitamins (Lestari and Deswiniyanti, 2017).

One of the potential organic materials to be used in culture media is sweet potato extract. Sweet potato (*Ipomoea batatas* L.) is a carbohydrate source rich in micronutrients such as B-complex vitamins, vitamin C, vitamin E, provitamin A and iron

(Putri *et al*., 2023). The addition of organic materials to the culture media should consider their chemical composition, ensuring they do not contain compounds that can inhibit plant growth.

As a carbon source, sweet potatoes can provide the energy required in the process of cell division and enlargement. Sweet potatoes exhibit a variety of flesh colors, which indicates differences in the content of bioactive compounds. White sweet potatoes predominantly contain amylose (starch), yellow sweet potatoes are rich in beta-carotene, and purple sweet potatoes contain anthocyanins. In this study, three types of sweet potato─white, yellow, and purple─were used to evaluate the effect of adding sweet potato extract in the media on the growth of *Cattleya* orchid subcultures.

Research by Mardiana and Shantidewi (2023) showed that the addition of 150 $g \cdot L^{-1}$ white sweet potato extract combined with 0.25 ppm IAA produced the best length and number of roots in Moon orchids. Similar results were reported by Meilani *et al.* (2017), who found that 75 $g \cdot L^{-1}$ white sweet potato extract affects leaf length, 150 $g \cdot L^{-1}$ affects root length, and 300 $g \cdot L^{-1}$ affects leaf width. Research by Moda *et al*. (2021) also showed that purple sweet potato extract at a concentration of 400-500 $g \cdot L^{-1}$ had a positive effect on planlet height, root length, and leaf length of Moon orchids.

METHODOLOGY

This study is an experimental research conducted at the Laboratory of Plant Physiology and Biotechnology, Department of Agroecotechnology, Faculty of Agriculture, Sultan Ageng Tirtayasa University, Serang City, Banten. Research activities were carried out during the period November 2024 to March 2025.

The instruments and materials used in this study included erlenmeyer, measuring cup, beaker glass, analytical balance, laminar air flow (LAF), autoclave, hotplate, magnetic stirrer, blender, UC bottle, filter cloth, scalpel, blade, tweezers, micropipette, spatula, petri dish, pH indicator, bunsen, spray bottle, ruler, stationery, instant MS media, 70% alcohol, distilled water, tips, sugar, agar, HCl, NaOH, PPM, aluminum foil, plastic wrap, tissue, label, spirtus, clorox, and sterile *Cattleya* orchid explants and three types of sweet potato: white, yellow, purple.

The research design used was a Randomized Block Design (RBD) with two factors. The first factor was the type of sweet potato consisting of three levels, namely white sweet potato (U1), yellow sweet potato (U2), and purple sweet potato (U3). The second factor was sweet potato extract concentration, consisting of four levels: 50 $g \cdot L^{-1}$ (K1), 100 $g \cdot L^{-1}$ (K2), 150 $g \cdot L^{-1}$ (K3), and 200 $g \cdot L^{-1}$ (K4). There were 12 treatment combinations, each of which was repeated three times, resulting in a total of 36 experimental units. The linear model of this research design is as follows:

$$Y_{ijk} = \mu + \tau_i + \beta_j + (\alpha\beta)_{ij} + \rho_k + \varepsilon_{ij}$$

Note:

Y_{ijk}	Observation value of the *i*-th sweet potato extract concentration, *j*-th sweet potato type, and *k*-th block (group)
μ	Overall mean
α_i	Effect of the *i*-th sweet potato extract concentration
β_j	Effect of the *j*-th sweet potato type
$(\alpha\beta)_{ij}$	Interaction effect between sweet potato extract concentration anf sweet potato type
ρ_k	Effect of th e*k*-th block (group)
ε_{ij}	Experimental error associated with the *ijk*-th observation
i	1,2,3,4 (concentration)
j	1,2,3 (sweet potato types)
k	1,2,3 (repeat)

Parameters observed in this study included root emergence time, shoot emergence time, increase in shoot number, explant height increase, leaf number increment and explant survival percentag. Observation data were analyzed using analysis of variance (ANOVA). If there was a significant difference, it was followed by Duncan's Multiple Range Test (DMRT) at the 5% level.

The stages of this study included explant preparation and sterilization of tools and materials. Tools were sterilized using an autoclave at 121℃ and 1 atm pressure for 20 minutes, while materials were sterilized under the same conditions for 15 minutes. Next, the sweet potato extract stock solution was prepared: each type of sweet potato was peeled and weighed as much as 60 grams, blended with 100 mL of distilled water, then measured to 200 mL. The extract was then diluted according to the formula $V_1M_1=V_2M_2$, followed by the preparation sterilization of instant MS media.

Explant planting was done one week after media incubation and planting was done in LAF. *Cattleya* orchid planlet shoots with a size of 0.5-1.5 cm were used as explants and planted into the prepared media. After planting, periodic parameter observations were conducted, and the data were analyzed according to the experimental design.

RESULTS AND DISCUSSION

The results of this study indicate that the addition of media with various types and concentrations of sweet potato extract affects the growth of *Cattleya* orchid subcultures, as presented in Table 1.

Table 1. Summary of the analysis of variance (ANOVA) for shoot emergence time (WAP), increase in shoot number, increase in explant height, and increase in explant leaf number of Cattleya orchids with the addition of media containing different types and concentrations of sweet potato extract in vitro.

No	Observation Parameter	Plant Age (WAP)	Treatment			KK
			Sweet Potato Type	Extract Concentration	Interaction	
1	Shoot Emergence Time	4	ns	ns	ns	18,70[a]
2	Increase in Shoot Number	4	ns	ns	ns	12,69[b]
		6	ns	ns	ns	10,23[b]
		8	ns	ns	ns	8,42[b]
		10	ns	ns	ns	8,44[b]
		12	ns	ns	ns	5,02[b]
3	Increase in Explant Height	4	*	ns	ns	9,10[a]
		6	ns	ns	ns	7,97[a]
		8	ns	ns	ns	6,41[a]
		10	ns	ns	ns	8,70[a]
		12	ns	ns	ns	7,39[a]
4	Increase in Leaf Number	4	ns	ns	ns	12,21[b]
		6	ns	ns	*	7,80[b]
		8	ns	ns	ns	11,20[b]
		10	ns	ns	ns	9,30[b]
		12	ns	ns	ns	12,74[b]

Note: *: Significant at 5% level, ns: not significant

Based on the ANOVA results in Table 1, the growth of *Cattleya* orchid subcultures varied depending on the treatment factors. The sweet potato type treatment showed a significant effect on the increase in explant height at 4 weeks after planting (WAP). There was an interaction between sweet potato type and extract concentration that significantly influenced the increase in leaf number at 6 WAP. Meanwhile, this study found no significant effect on root emergence time, shoot emergence time, and increase in shoot number

Root Emergence Time

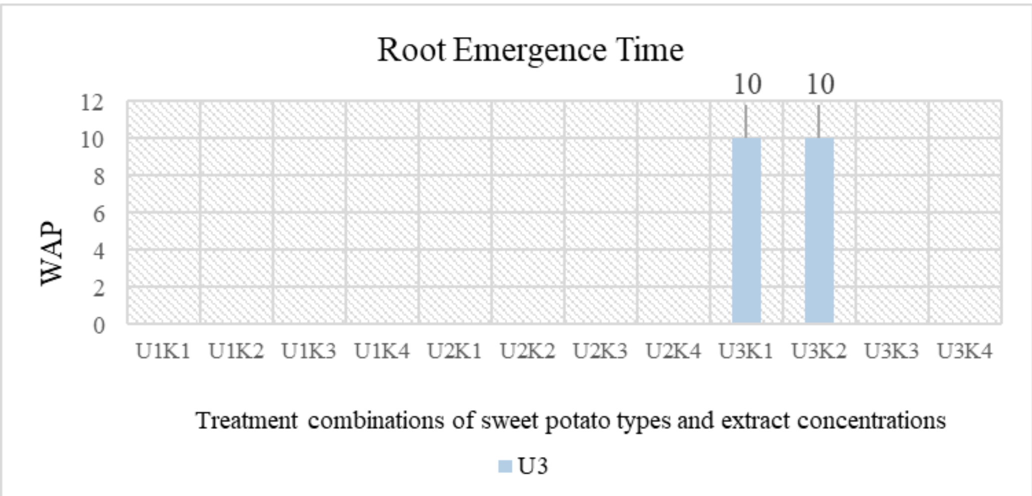
Root emergence in tissue culture indicates that the explants grown *in vitro* are in a healthy condition, as roots play a role in nutrient absorption. According to Graph 1, two treatment combinations in the third replication showed root emergence at 10 WAP. All treatments in the first and second replications did not exhibit root emergence, so the data were not included in the bar graph.

The treatment combinations that exhibited root emergence were U3K1 and U3K2, corresponding to purple sweet potato extract at concentrations of 50 g·L^{-1}and 100 g·L^{-1}, respectively. No other treatment combinations showed root formation by the end of the observation period at 12 WAP. The treatments using purple sweet potato were able to induce root emergence, albeit delayed. Purple sweet potatoes contain several bioactive compounds, such as anthocyanins, flavonoids, and polyphenols. Noli *et al*. (2025) explained that phenolic compounds can interfere with enzyme function and activity, leading to root growth inhibition. The concentrations of purple sweet potato extract that induced root formation (50 g·L^{-1}and 100 g·L^{-1}) were relatively low, meaning the amount of soluble phenolics in the medium was also low. This aligns with Putri *et al*. (2025), who stated that higher concentrations of purple sweet potato extract indicate higher levels of bioactive compounds. These findings suggest that while phenolics inhibit root growth, at low concentrations in the medium, roots can still form on the explants.

Shoot Emergence Time

Based on Table 1, the ANOVA summary indicated that neither sweet potato type nor extract concentration had a significant effect on shoot emergence time in *Cattleya* orchids, nor was there any interaction between the two treatments. The average shoot emergence time data are presented in Table 2.

The data presented in Table 4 show that the average shoot emergence time of *Cattleya* orchids treated with different sweet potato extract concentrations ranged between 3.78 to 4.22 WAP, while treatments with different sweet potato types resulted in emergence times of 3.83 to 4.17 WAP. This indicates that both sweet potato type and extract concentration exerted similar effects on shoot emergence time in *Cattleya* orchids.



Graph 1. Root emergence time in the 3rd replication

Table 2. Observed shoot emergence time of *Cattleya* orchid explants with the addition of media containing different types and concentrations of sweet potato extract *in vitro*.

Sweet Potato Type (U)	Sweet Potato Concentration (K)				Average
	K_1 (50 g·L^{-1})	K_2 (100 g·L^{-1})	K_3 (150 g·L^{-1})	K_4 (200 g·L^{-1})	
.... (WAP)					
U_1 (White Sweet Potato)	4,00	3,33	4,67	4,67	**4,17**
U_2 (Yellow Sweet Potato)	4,00	4,67	3,33	3,33	**3,83**
U_3 (Purple Sweet Potato)	4,00	4,67	3,33	4,00	**4,00**
Average	**4,00**	**4,22**	**3,78**	**4,00**	**4,00**

The fastest shoot emergence (3.3 WAP) was achieved by treatment combinations U1K2, U2K3, and U3K3. All sweet potato types−white (U1), yellow (U2), and purple (U3)−showed similar effects in accelerating shoot emergence, despite their differing phytochemical contents (such as anthocyanins in purple or beta-carotene in yellow varieties) not significantly influencing shoot emergence time. While balanced cytokinin and auxin growth regulators can accelerate shoot emergence, these compounds do not naturally occur in sweet potatoes, explaining their non-significant effect.

Treatments with sweet potato extract concentrations of 100 g·L^{-1} (K2) and 150 g·L^{-1} (K3) demonstrated faster shoot emergence compared to other concentrations, suggesting these ranges approach optimal levels for accelerating shoot development.

Increase in Shoot Number

The number of shoots growing in subcultured explants indicates successful shoot formation in tissue culture media, which may occur either directly as shoots or indirectly through callus formation first. Shoot formation from explant tissues is determined by plant genetic factors, with tissue type and physiological age also influencing organogenesis (Prasetyorini, 2019). As shown in Table 1, ANOVA results indicated that neither sweet potato type nor extract concentration had significant effects on shoot number increase in *Cattleya* orchids.

According to Table 3, neither sweet potato variety nor extract concentration showed significant effects on shoot multiplication. The treatments with sweet potato extract concentrations of 50 g·L^{-1} and 200 g·L^{-1} yielded the highest average shoot increase (1.22 shoots), while purple sweet potato treatments showed the maximum average increase of 1.17 shoots. These findings align with Meilani *et al*. (2017), who reported that higher concentrations of sweet potato extract tend to promote better shoot formation, with 300 g·L^{-1} extract producing the highest number of new shoots compared to lower concentrations.

All treatments with different sweet potato varieties or extract concentrations showed non-significant differences in average shoot multiplication, indicating no substantial effect on shoot proliferation. As suggested by Luftiani *et al*. (2022), variations in shoot numbers may result from differences in explants' nutrient absorption capacity or media nutrient supply. Shoot multiplication can also be influenced by explants' adaptation ability in the limited growth space of culture vessels.

Explant Height Increase

Explant height, measured as growth indicator through elongation observation, serves as a parameter to evaluate treatment effects and environmental conditions on explant development. ANOVA results in Table 1 demonstrate that sweet potato variety significantly affected *Cattleya* orchid explant height at 4 WAP.

Table 3. Observed increase in shoot number of *Cattleya* orchids with the addition of media containing different types and concentrations of sweet potato extract in vitro

Sweet Potato Type (U)	Sweet Potato Concentration (K)				Average
	K_1 (50 g·L^{-1})	K_2 (100 g·L^{-1})	K_3 (150 g·L^{-1})	K_4 (200 g·L^{-1})	
2 WAP					
U_1 (White Sweet Potato)	0,00	0,67	0,67	0,00	0,33
U_2 (Yellow Sweet Potato)	0,33	0,33	0,67	0,33	0,42
U_3 (Purple Sweet Potato)	0,00	0,00	0,67	0,33	0,25
Average	**0,11**	**0,33**	**0,67**	**0,22**	**0,33**
4 WAP					
U_1 (White Sweet Potato)	1,67	0,67	0,00	1,00	0,83
U_2 (Yellow Sweet Potato)	0,33	1,33	1,00	1,33	1,00
U_3 (Purple Sweet Potato)	1,67	0,67	1,00	1,33	1,17
Average	**1,22**	**0,89**	**0,67**	**1,22**	**1,00**
6 WAP					
U_1 (White Sweet Potato)	0,33	1,33	0,67	1,67	1,00
U_2 (Yellow Sweet Potato)	0,67	0,33	0,33	0,33	0,42
U_3 (Purple Sweet Potato)	0,00	0,67	1,33	0,33	0,58
Average	**0,33**	**0,78**	**0,78**	**0,78**	**0,67**
8 WAP					
U_1 (White Sweet Potato)	0,33	0,33	0,33	1,00	0,50
U_2 (Yellow Sweet Potato)	0,33	0,33	0,00	0,00	0,17
U_3 (Purple Sweet Potato)	0,67	0,33	0,00	1,00	0,50
Average	**0,44**	**0,33**	**0,11**	**0,67**	**0,39**
10 WAP					
U_1 (White Sweet Potato)	0,00	0,00	0,33	1,33	0,42
U_2 (Yellow Sweet Potato)	0,00	0,33	0,67	0,67	0,42
U_3 (Purple Sweet Potato)	0,00	0,33	0,00	0,00	0,08
Average	**0,00**	**0,22**	**0,33**	**0,67**	**0,31**
12 WAP					
U_1 (White Sweet Potato)	0,33	0,00	0,00	0,33	0,17
U_2 (Yellow Sweet Potato)	0,00	0,00	0,00	0,00	0,00
U_3 (Purple Sweet Potato)	0,00	0,00	0,00	0,33	0,08
Average	**0,11**	**0,00**	**0,00**	**0,22**	**0,08**

Table 4. Observed height increase of *Cattleya* orchid explants cultured in media supplemented with various types and concentrations of sweet potato extract in vitro.

Sweet Potato Type (U)	Sweet Potato Concentration (K)				Average
	K_1 (50 g·L^{-1})	K_2 (100 g·L^{-1})	K_3 (150 g·L^{-1})	K_4 (200 g·L^{-1})	
	.... **(cm)**				
2 WAP					
U_1 (White Sweet Potato)	0,20	0,25	0,15	0,21	0,20
U_2 (Yellow Sweet Potato)	0,18	0,13	0,22	0,19	0,18
U_3 (Purple Sweet Potato)	0,18	0,32	0,31	0,26	0,27

Average	**0,19**	**0,24**	**0,23**	**0,22**	**0,22**
			4 WAP		
U_1 (White Sweet Potato)	0,91	0,86	0,87	0,82	0,86ab
U_2 (Yellow Sweet Potato)	0,80	0,81	0,83	0,81	0,81b
U_3 (Purple Sweet Potato)	0,88	0,87	0,95	0,89	0,90a
Average	**0,86**	**0,85**	**0,89**	**0,84**	**0,86**
			6 WAP		
U_1 (White Sweet Potato)	0,16	0,28	0,14	0,21	0,19
U_2 (Yellow Sweet Potato)	0,09	0,27	0,24	0,10	0,18
U_3 (Purple Sweet Potato)	0,15	0,15	0,19	0,17	0,17
Average	**0,14**	**0,22**	**0,19**	**0,16**	**0,18**
			8 WAP		
U_1 (White Sweet Potato)	0,20	0,14	0,11	0,21	0,17
U_2 (Yellow Sweet Potato)	0,10	0,15	0,08	0,11	0,11
U_3 (Purple Sweet Potato)	0,14	0,18	0,15	0,16	0,16
Average	**0,14**	**0,16**	**0,11**	**0,16**	**0,14**
			10 WAP		
U_1 (White Sweet Potato)	0,18	0,16	0,14	0,10	0,14
U_2 (Yellow Sweet Potato)	0,15	0,18	0,27	0,27	0,22
U_3 (Purple Sweet Potato)	0,17	0,17	0,15	0,17	0,17
Average	**0,17**	**0,17**	**0,19**	**0,18**	**0,18**
			12 WAP		
U_1 (White Sweet Potato)	0,17	0,23	0,11	0,14	0,16
U_2 (Yellow Sweet Potato)	0,09	0,11	0,16	0,09	0,11
U_3 (Purple Sweet Potato	0,17	0,14	0,12	0,08	0,13
Average	**0,14**	**0,15**	**0,13**	**0,10**	**0,13**

Note: Numbers followed by the same letter in the same row and column indicate significant differences based on DMRT 5% post-hoc test.

Based on Table 4, the DMRT 5% results for explant height increment at 4 WAP showed the best response with purple sweet potato treatment, yielding an average explant height increment of 0.90 cm. This was superior to white sweet potato treatment (average 0.86 cm) and yellow sweet potato treatment (average 0.81 cm).

The significant effect of purple sweet potato treatment on explant height increment is attributed to its high anthocyanin content. Anthocyanins are flavonoid compounds known for their strong antioxidant activity. This activity helps protect plant tissues from damage caused by free radicals in the culture environment, which would otherwise inhibit explant growth. The enhanced height increment of explants is supported by these antioxidants, facilitating healthy growth. Setoguchi *et al*. (2023) reported that purple sweet potatoes accumulate a large quantity of anthocyanins, which are secondary metabolites that play a role in plant defense against stress conditions. This finding aligns with the research by Hartati *et al*. (2021), which showed the highest plantlet development in treatments supplemented with purple sweet potato organic matter.

Leaf Number Increment

The number of leaves serves as a key indicator of plant growth and provides additional information to elucidate the growth processes occurring. An increase in leaf number also suggests that the explants are capable of optimal photosynthesis. According to Table 1, the recapitulation of the analysis of variance indicated a significant interaction between the type of sweet potato and the concentration of sweet potato extract on the increase in the number of *Cattleya* orchid leaves at 6 WAP.

Table 5. Observed results of *Cattleya* orchid leaf number increment with the addition of various sweet potato types and concentrations in the culture medium *in vitro*

Sweet Potato Type (U)	**Sweet Potato Concentration (K)**				**Average**
	K_1 (50 g·L^{-1})	K_2 (100 g·L^{-1})	K_3 (150 g·L^{-1})	K_4 (200 g·L^{-1})	
……………………………… **(strands)** ………………………………					
2 WAP					
U_1 (White Sweet Potato)	0,67	0,33	0,67	0,33	0,50
U_2 (Yellow Sweet Potato)	1,00	0,33	0,67	0,67	0,67
U_3 (Purple Sweet Potato)	0,00	0,67	0,67	0,00	0,33
Average	**0,56**	**0,44**	**0,67**	**0,33**	**0,50**
4 WAP					
U_1 (White Sweet Potato)	3,00	1,33	2,00	1,33	1,92
U_2 (Yellow Sweet Potato)	1,67	2,00	1,67	1,00	1,58
U_3 (Purple Sweet Potato)	1,33	2,33	1,00	1,67	1,58
Average	**2,00**	**1,89**	**1,56**	**1,33**	**1,69**
6 WAP					
U_1 (White Sweet Potato)	1,77a	1,46abc	1,10bc	1,34abc	1,67
U_2 (Yellow Sweet Potato)	1,34abc	0,88c	1,46abc	1,22abc	1,08
U_3 (Purple Sweet Potato)	1,22abc	1,56ab	1,22abc	1,46abc	1,42
Average	**1,67**	**1,33**	**1,22**	**1,33**	**1,39**
8 WAP					
U_1 (White Sweet Potato)	1,33	1,00	1,33	1,33	1,25
U_2 (Yellow Sweet Potato)	0,67	0,67	0,67	0,33	0,58
U_3 (Purple Sweet Potato)	1,33	0,00	0,33	1,33	0,75
Average	**1,11**	**0,56**	**0,78**	**1,00**	**0,86**
10 WAP					
U_1 (White Sweet Potato)	2,33	2,33	1,00	2,33	2,00
U_2 (Yellow Sweet Potato)	1,00	2,00	2,33	2,00	1,83
U_3 (Purple Sweet Potato)	1,00	1,00	1,33	1,33	1,17
Average	**1,44**	**1,78**	**1,56**	**1,89**	**1,67**
12 WAP					
U_1 (Ubi Putih)	1,67	0,33	1,33	2,33	1,42
U_2 (Ubi Kuning)	1,33	0,67	1,67	0,67	1,08
U_3 (Purple Sweet Potato)	1,00	0,33	2,00	1,67	1,25
Average	**1,33**	**0,44**	**1,67**	**1,56**	**1,25**

Note: Numbers followed by the same letter in the same row and column indicate no significant difference at DMRT 5% post-hoc test.

Table 5 indicates that the interaction of treatment U1K1 at 6 WAP yielded the highest average number of leaves, specifically 1.77 leaves. However, this was not significantly different from the U3K2 treatment, which resulted in an average leaf increase of 1.56 leaves. This interaction is likely due to the specific combination of sweet potato type and extract concentration providing an optimal and mutually supportive balance of components. The interaction between white sweet potato and 50 $g \cdot L^{-1}$ sweet potato extract concentration (U1K1) was not significantly different from the interaction between purple sweet potato and 100 $g \cdot L^{-1}$ sweet potato extract concentration (U3K2). The carbohydrate content in purple sweet potatoes is relatively comparable to that of white sweet potatoes, suggesting that the optimal concentration for purple sweet potato extract is not necessarily the highest concentration, but rather 100 $g \cdot L^{-1}$.

The interaction of yellow sweet potato with 150 $g \cdot L^{-1}$ sweet potato extract concentration (U2K3) produced the highest average number of leaves at 1.46 leaves, although this was the lowest quantity compared to other sweet potato types. This observation might be attributed to the dominant beta-carotene compounds in yellow sweet potatoes being more effective in supporting plant growth when naturally present within plant tissues, as opposed to when beta-carotene is externally added to the culture medium, which could potentially reduce its effectiveness. According to Bermejo *et al.* (2021), beta-carotene protects chloroplasts from sunlight stress, thereby preventing inhibition of photosynthesis. This explanation remains speculative as the use of yellow sweet potato extract as a tissue culture medium additive has not been previously investigated. Nevertheless, theoretically, beta-carotene content within plant tissues plays a role in supporting plant growth, including leaf formation.

Explant Survival Percentage

The explant survival percentage represents the proportion of explants that successfully grow in *in vitro* culture after receiving a specific treatment. This parameter aims to assess the ability of *in vitro* cultured explants to adapt and survive on the tissue culture growth medium.

Table 6. Percentage of *Cattleya* orchid explant survival with the addition of various sweet potato types and concentrations of sweet potato extract *in vitro*

Treatment	Number of Explants	Number of Living Explants	Percentage of Living Explants (%)
U1K1	3	3	100%
U2K1	3	3	100%
U3K1	3	3	100%
U1K2	3	3	100%
U2K2	3	3	100%
U3K2	3	3	100%
U1K3	3	3	100%
U2K3	3	3	100%
U3K3	3	3	100%
U1K4	3	3	100%
U2K4	3	3	100%
U3K4	3	3	100%
Total	36	36	100%

Based on Table 6, the survival rate of explants throughout the 12 weeks of observation was 100% across all treatment media. All *Cattleya* orchid explants subcultured were able to survive without contamination from either fungi or bacteria. This high explant survival rate also indicates that the use of sweet potato extract in the medium can effectively support the growth of *Cattleya* orchid explants. All explants demonstrated adaptability to various types of sweet potato due to their rich vitamin content. Yellow sweet potatoes, specifically, contain antioxidants from beta-carotene compounds, which can protect explants from browning. According to Permadi *et al*. (2024), the ability of antioxidants to react with oxygen within the culture vessel can prevent the browning process. Purple sweet potatoes contain a relatively high concentration of natural pigments, namely anthocyanins, compared to other sweet potato varieties. Paramita *et al*. (2021) elucidated that anthocyanins extracted from purple sweet potatoes exhibit antibacterial activity by inhibiting the growth of gram-positive bacteria. This suggests that purple sweet potato extract in tissue culture media can function as an antibacterial agent and prevent contamination. Explant survival is maintained as long as contamination is prevented.

White sweet potatoes are rich in carbohydrates, particularly starch, which can provide energy for optimal explant growth. Explant viability is further supported by the carbon source supplied by the carbohydrates in white sweet potatoes. Darmawati and Yuswanti (2014) state that carbohydrates in culture media not only serve as a carbon and energy source for explants but also regulate osmotic pressure stability, which is crucial for explant growth. Uncontrolled osmotic pressure can impair the absorption of water and nutrients essential for explant development.

CONCLUSION AND RECOMMENDATION

The treatment with purple sweet potato significantly affected the increase in height of *Cattleya* orchid explants at 4 weeks after planting (WAP), with an average height increment of 0.90 cm. Furthermore, an interaction was observed between white sweet potato treatment and 50 $g{\cdot}L^{-1}$ sweet potato extract concentration (U1K1) on the increase in the number of leaves of *Cattleya* orchid explants at 6 WAP, yielding 1.77 leaves. The single treatment of sweet potato extract concentration showed no significant effect on any observed parameter. Therefore, it is recommended to subculture *Cattleya* orchids with the addition of white and purple sweet potato extract at a concentration of 50 $g{\cdot}L^{-1}$ to achieve optimum growth response.

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