Documents

Puad, N.I.M.[a] , Mze, S.A.I.[a] , Azmi, A.S.[a] , Abduh, M.Y.[b]

THE INFLUENCE OF PLANT GROWTH REGULATORS AND LIGHT SUPPLY ON BITTER CASSAVA CALLUS INITIATION FOR STARCH PRODUCTION

(2024) *IIUM Engineering Journal*, 25 (1), pp. 1-11.

DOI: 10.31436/iiumej.v25i1.2585

[a] Department of Chemical Engineering and Sustainability, Kulliyyah of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[b] School of Life Sciences and Technology, Institut Teknologi Bandung, Jalan Ganesha, No. 10, Bandung, 40132, Indonesia

Abstract
The application of cassava starch in the biopolymers industry has been growing significantly due to its low cost, good oxygen barrier in the dry state, and biodegradability. Plant culture technology is an alternative to traditional propagation as it does not require large areas for production, has a higher rate of multiplication, and produces disease-free plants. However, the application of cassava callus culture for starch production is limited. This study focuses on identifying the significant culture parameters for a maximum Rayong cultivar cassava callus growth and evaluation of its starch content. Cassava stems petiole and leaf explants were cultured on MS medium containing different combinations of 2,4-D (8, 12, and 15 mg/L) and BAP (1, 3, and 5 mg/L) under three light conditions (0, 16, and 24 h). The screening of the most influential parameter was done using the 2-level Factorial Design in Design Expert v13 by analyzing the frequency of callus formation. All leaf explant turned brown with no callus induction. The highest frequency of callus formation derived from stem petiole explant was achieved by the combination of 8 mg/L 2,4-D and 1 mg/L BAP under the light condition (75%) followed by 8 mg/L 2,4 D + 1 mg/L BAP under the dark condition (50%). Based on the ANOVA analysis, the individual supply of 2,4-D and BAP respectively, have a negative effect on callus formation while the combination of 2,4-D and BAP has a positive effect. Light supply did not significantly affect cassava callus formation. The amount of starch in the cassava callus was then investigated using an iodine test which yielded 0.21% of the total weight of the callus (0.0101g). The amount of starch is relatively low considering that the callus was not grown under the optimum condition for starch production. The findings of this study open prospects for future research in cassava cultures in favor of starch production.

Author Keywords
2,4-dichlorophenoxyacetic acid (2,4-D); 6-benzylaminopurine (BAP); callus culture; cassava; light

Funding details
Ministry of Higher Education, MalaysiaMOHEFRGS/1/2021/STG01/UIAM/02/2
International Islamic University MalaysiaIIUMRMCG20-018-0018

We would like to acknowledge the Ministry of Higher Education Malaysia for funding this project under the Fundamental Research Grant Scheme (FRGS/1/2021/STG01/UIAM/02/2). In addition, the authors are grateful to the management of the International Islamic University Malaysia (IIUM) for a research fund (RMCG20-018-0018) for this work. Department of Chemical Engineering and Sustainability, Kulliyyah of Engineering, IIUM for providing the laboratory facilities to conduct this study. We also thanked NGP Technology Sdn. Bhd. for providing us with cassava cuttings to be planted at IIUM and then used as the explants to initiate cassava cultures.

References

- Tan, SL.
  Cassava – Silently, The Tuber Fills
  (2015) *UTAR Agriculture Science Journal*, 1 (2), pp. 12-24.
  [1]

- Li, S, Cui, Y, Zhou, Y, Luo, Z, Liu, J, Zhao, M.
  The industrial applications of cassava: current status, opportunities and prospects
  (2017) *Journal of the Science of Food and Agriculture*, 97 (8), pp. 2282-2290.
  [2]

- Tumwesigye, KS, Oliveira, JC, Namuwaya, S, Sousa-Gallagher, MJ.
  Cassava Biomaterial Innovations for Industry Applications
  (2021) *Cassava - Biology, Production, and Use. IntechOpen*,
  [3] (Ed)

- *Cassava Starch Market, Consumption & Global Forecast*,
[4] Available
- Howeler, R, Cain, P, Trumbore, L, Hidajat, SU.
The challenge of large-scale cassava production
(2012) *Sustainable Cassava Production in Asia for Multiple Uses and for Multiple Markets Proceedings 9th Regional Cassava Workshop*, pp. 313-321.
[5]
- NurulNahar, E, Tan, SL.
Cassava mini-cuttings as a source of planting material
(2012) *J. Trop. Agric. and Fd. Sc*, 40 (1), pp. 145-151.
[6]
- Hussain, A, Ahmed, I, Nazir, H, Ullah, I.
Plant Tissue Culture: Current Status and Opportunities
(2012) *Recent Advances in Plant in Vitro Culture*, 37 (3), pp. 5-30.
[7]
- Abdalla, N, Ragab, M, El-Miniawy, S, Taha, H.
Callus induction, regeneration and molecular characterization of cassava (Manihot esculenta Crantz)
(2013) *Journal of Applied Sciences Research*, 9, pp. 3781-3790.
[8]
- Faye, A, Sagna, M, Kane, PD, Sane, D.
Effects of different hormones on organogenesis in vitro of some varieties of cassava (Manihot esculenta Crantz) grown in Senegal
(2015) *African Journal of Plant Science*, 9 (8), pp. 305-312.
[9]
- Mahdi, H, Edward, R.
In vitro propagation of selected Malaysia cassava (Manihot esculenta Crantz) varieties by using nodal explants
(2018) *Malaysian Applied Biology*, 47 (1), pp. 1-5.
[10]
- Prammanee, S., Kamprerasart, K, Salakan, S, Sriroth, K.
Growth and starch content evaluation on newly released cassava cultivars, Rayong 9, Rayong 7 and Rayong 80 at different harvest times
(2010) *Kasetsart J*, 44, pp. 558-563.
[11]
- Fletcher, EKA, Amoako, TNE, Twumasi, P.
Effect of 2,4-D, explants type and cultivar on the callogenesis expression of cassava (Manihot esculenta Crantz) in Ghana
(2011) *African Journal of Biotechnology*, 10 (46), pp. 9396-9401.
[12]
- Puad, NIM, Sofri, NSNM, Amid, A, Azmi, AS.
Optimization of Surface Sterilization Method and Initiation of Bitter Cassava Callus Culture
(2022) *Biological and Natural Resources Engineering Journal*, 6 (1), pp. 47-59.
[13]
- Puad, NIM, Tang, CW.
A simple and Easy Method for Preparing Solid and Liquid Media for Plant Culture
(2015) *Experimental Methods in Modern Biotechnology*, 3.
[14] IIUM Press, Malaysia

- Reddy, DK, Bhotmange, MG.
Isolation of Starch from Rice (Oryza sativa L.) and its Morphological Study using Scanning Electron Microscopy
(2013) *International Journal of Agriculture and Food Science Technology*, 4 (9), pp. 859-866.
[15]

- Bello, OA, Esan, EB, Obembe, OO.
Establishing surface sterilization protocol for nodal culture of Solanecio biafrae
(2018) *IOP Conference Series: Earth and Environmental Science*, 210, p. 012007.
[16]

- Hesami, M, Naderi, R, Tohidfar, M, Yoosefzadeh-Najafabadi, M.
Modeling and Optimizing in vitro Sterilization of Chrysanthemum via Multilayer Perceptron-Non-dominated Sorting Genetic Algorithm-II (MLP-NSGAII)
(2019) *Frontiers in Plant Science*, 10.
[17]

- Anderson, MJ, Whitcomb, PJ.
Two-level Factorial Design
(2015) *DOE Simplified: Practical Tools for Effective Experimentation*,
[18]

- Ullah, H, Ullah, I, Jadoon, SA, Rashid, H.
Tissue culture techniques for callus induction in rice
(2007) *Sarhad J. Agric*, 23 (1), pp. 81-86.
[19]

- Bano, AS, Khattak, AM, Basit, A, Alam, M, Shah, ST, Ahmad, N, Gilani, SAQ, Mohamed, HI.
Callus Induction, Proliferation, Enhanced Secondary Metabolites Production and Antioxidants Activity of Salvia moorcroftiana L. as Influenced by Combinations of Auxin, Cytokinin and Melatonin
(2022) *Brazilian Archives of Biology and Technology*, 65, p. e22210200.
[20]

- Junairiah, J, Purnomo, P, Utami, ESW, Ni‘matuzahroh, N, Sulistyorini, L.
Callus Induction of Piper betle L. Var Nigra Using 2,4-Dichlorofenoxyacetic Acid and 6-Benzil Aminopurin
(2018) *Biosaintifika: Journal of Biology & Biology Education*, 10 (3), pp. 588-596.
[21]

- Chutipaijit, S, Sutjaritvorakul, T.
Titanium dioxide (TiO2) nanoparticles induced callus induction and plant regeneration of indica rice cultivars (suphanburi1 and suphanburi90)
(2018) *Digest Journal of Nanomaterials and Biostructures*, 13 (4), pp. 1003-1010.
[22]

- Ozarowski, M.
Influence of the physico-chemical factors, plant growth regulators, elicitors and type of explants on callus cultures of medicinal climbers of Passiflora l. L
(2011) *Herba Polonica*, 57 (4), pp. 58-75.
[23]

- Carciofi, M, Blennow, A, Nielsen, MM, Holm, PB, Hebelstrup, KH.
Barley callus: a model system for bioengineering of starch in cereals
(2012) *Plant Methods*, 8 (1), pp. 1-10.
[24]

- Efferth, T.
Biotechnology Applications of Plant Callus Cultures

(2019) *Engineering*, 5 (1), pp. 50-59.
[25]

- Lee, ST, Huang, WL.
Cytokinin, auxin, and abscisic acid affects sucrose metabolism conduce to de novo shoot organogenesis in rice (Oryza sativa L.) callus
(2013) *Botanical Studies*, 54 (1), pp. 1-11.
[26]

Correspondence Address
Puad N.I.M.; Department of Chemical Engineering and Sustainability, Malaysia; email: illi@iium.edu.my

Publisher: International Islamic University Malaysia-IIUM

ISSN: 1511788X
Language of Original Document: English
Abbreviated Source Title: IIUM Eng. J.
2-s2.0-85187179464
Document Type: Article
Publication Stage: Final
Source: Scopus