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Polyploidy induction in 'Bentong' ginger as a strategy for genetic improvement

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Abstract

Ginger (*Zingiber officinale* Roscoe) is a globally important crop valued for its culinary, medicinal, and industrial applications. Its bioactive compounds, particularly gingerols and shogaols, are well documented for their antioxidant, antimicrobial, anti-inflammatory, and anticancer properties. Despite its significance, poor natural flowering and seed set severely limit conventional breeding efforts in ginger, resulting in persistently low productivity and narrow genetic diversity. This study explored *in vitro* polyploidy induction as an alternative genetic improvement strategy for 'Bentong' ginger, a premium ginger cultivar widely grown in Malaysia. Oryzalin and amiprofos-methyl (APM) were applied at 20, 40, 60, 80, and 100 μM, while colchicine (5 mM) served as a positive control. All treatments were supplemented with 2 % dimethyl sulfoxide (DMSO) in Murashige and Skoog (MS) basal medium to enhance cellular uptake of the antimitotic agents. Two control treatments, MS liquid medium with and without 2 % DMSO, were included for comparison. Putative polyploid plants were initially screened based on stomatal size, stomatal density, and chloroplast number per guard cell as indicators for polyploidy. Selected candidate plants were subsequently confirmed for ploidy level using flow cytometry analysis. Among all treatments, APM at 60 μM proved the most effective antimitotic agent, achieving the highest tetraploidy induction rate of 55.56 %. Confirmed tetraploid plants demonstrated superior growth and physiological performance compared to their diploid counterparts, including earlier rhizome initiation and significantly higher rhizome yield. Furthermore, tetraploid plants exhibited improved accumulation of bioactive compounds and enhanced antioxidant activity, suggesting greater medicinal and nutritional potential. These findings demonstrate that polyploidy induction is a viable and sustainable strategy for improving ginger productivity, enhancing its nutritional and medicinal value, and supporting long-term food security.

Keywords: Amiprofos-methyl, flow cytometry, oryzalin, tetraploid, *Zingiber officinale*

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