E CONF SERIES

International Conference on Modern Science and Scientific Studies
Hosted online from Madrid, Spain
Website: econfseries.com 20th June 2025

IMPROVING IN VITRO MICROTUBULE FORMATION IN POTATO (SOLANUM TUBEROSUM L.) THROUGH OPTIMIZED LIGHTING REGIMES

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Abstract

This study aims to optimize in vitro microtuber formation in the “Sarnav” potato variety. The effects of different photoperiods and explant sources were examined. Results showed that basal root explants exposed to 16:8 hours light/dark for 10 days, followed by darkness, produced the best tuberization. This protocol facilitates rapid screening of salt-tolerant genotypes and highlights the importance of exploring photoperiod and explant interactions.

Keywords: Microtuber, in vitro, photoperiod, explant source, tuberization, salt tolerance.

Introduction

Currently, potatoes are one of the main food crops in the world. To ensure its high yield and obtain high-quality varieties, modern biotechnological methods are used. One of the important directions for achieving rapid development of potato seedlings and high yields is microclonal in vitro production. Tuber formation in potato (Solanum tuberosum L.) is a complex physiological process regulated by trophic and hormonal factors. In regions with saline soils, such as Central Asia, developing salt-tolerant cultivars is a crucial agronomic task. In vitro culture systems are valuable tools in this regard, as they allow controlled observation of tuber formation and rapid assessment of genotypic variability.[3]Photoperiod (light/dark cycle) is one of the

key factors influencing tuber formation, with short-day conditions typically promoting this process. However, optimal photoperiod regimes for salt-tolerant genotypes are not fully studied. Additionally, the source of explants (which part of the plant they are derived from) significantly impacts tuber formation efficiency. In particular, basal explants are distinguished by their sensitivity to nutritional and hormonal signals. Therefore, it is necessary to thoroughly investigate the interaction between photoperiod and explant source.[1]

Research Objective

The main objective of this study is to optimize microtuber formation in the "Sarnav" potato variety under in vitro conditions. The specific aims are:

1. To determine the most effective photoperiod regime for microtuber formation;
2. To evaluate the effects of different explant sources;
3. To develop a reproducible in vitro protocol for salt-tolerant cultivars.

Materials and Methods

Explants were obtained from "Sarnav," "Navoi," and "Tashkent" potato cultivars. The "Sarnav" cultivar was grown in a greenhouse at 25±2°C with a 16:8 hour light:dark cycle for 4 weeks. Explants were taken from the apical (0.5–1 cm), middle (1–1.5 cm), and basal (1–1.5 cm) stem zones. Murashige and Skoog (MS) nutrient medium was used for in vitro culture, supplemented with 6% sucrose and 0.8% agar, adjusted to pH 5.7. Sterilization was carried out using 70% ethanol and 0.1% mercuric chloride. Cultures were maintained at 22±2°C with a light intensity of 40 µmol m^{-2} s^{-1}.

Table 1. Composition of the culture medium for in vitro microtuber formation.

Component	Concentration
MS basal salts	4.4 g/L
Sucrose	60 g/L
Agar	8 g/L
Ph	5.7

Six photoperiod regimes were studied:
1. Constant 16:8 (light:dark)
2. Constant 8:16
3. Continuous darkness
4. 10 days 16:8, followed by continuous darkness
5. 20 days 16:8, followed by continuous darkness
6. 30 days 16:8, followed by continuous darkness

In each condition, 30 explants were tested in 3 replicates.

Data Collection and Analysis

Over 60 days, the number and average fresh weight of microtubers were measured. Data were analyzed using ANOVA and Tukey HSD test at a 5% significance level. Standard errors were recorded as 0.008 for explant source and 0.011 for photoperiod.

Results

This study optimized in vitro microtuber formation in the 'Sarnav' potato cultivar to support rapid screening of salt-tolerant genotypes.The results showed that both photoperiod and explant source significantly affected microtuber formation.

Effect of Explant Source:The highest number (0.4475 ± 0.008 tubers/plant) and mass (120.5 ± 5.2 mg) of microtubers were observed in basal zone explants. Apical (0.2111 ± 0.008) and middle (0.2061 ± 0.008) explants showed significantly lower results.

Effect of Photoperiod: The 10-day regime of 16:8 light-dark cycle followed by continuous darkness produced the best results, yielding 0.4170 ± 0.011 tubers per plant and an average tuber weight of 125.8 ± 6.1 mg. The constant 8:16 cycle was the second most effective, while the constant 16:8 cycle resulted in the lowest yield. This indicates that the initial light exposure is crucial for stimulating tuber formation. The subsequent darkness likely provided optimal conditions for tuber growth and maturation. In contrast, prolonged light exposure may have favored vegetative growth over tuber development. These findings highlight the importance of optimizing light conditions in plant tissue culture for improved yields.

Analysis and Discussion

The high efficiency of basal explants is associated with their ability to effectively receive nutritional and hormonal signals. A 10-day light period (16:8) likely stimulated the initiation of tuber formation, while subsequent darkness provided favorable conditions for tuber growth. Prolonged light exposure (constant 16:8) promoted vegetative growth, thereby delaying tuber formation. This suggests that the balance between light and dark periods is crucial for optimizing tuber development. The initial light phase enhances photosynthesis, leading to increased energy reserves necessary for tuber initiation. In contrast, extended light may divert resources towards leaf and stem growth rather than tuberization. Understanding these dynamics can help refine cultivation practices to maximize tuber yield and quality.

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