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Chapter 7

Effects of ultraviolet (UV) radiation on microbial growth: Mechanisms, responses, and applications

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1. Introduction:

UV light, spanning from 4 nm to 400 nm within the visible spectrum, serves as a potent form of radiation. Widely utilized for surface sterilization, particularly in workspaces like transfer hoods for culture inoculation, UV light effectively eradicates bacteria. However, its effects extend beyond sterilization, contributing to harmful mutations with grave consequences (Harm, 1980). Upon absorption by DNA, UV light instigates the formation of pyrimidine dimers. These dimers arise from covalent bonding between adjacent thymine or cytosine molecules in DNA strands, altering the molecule's structure. Consequently, DNA polymerase encounters impediments in replicating DNA strands beyond dimer sites, inhibiting gene transcription (Sinha and Hader, 2002; Kageyama et al 2011; Reddy et al 2019a, b; Srivastava et al., 2022). Despite cellular repair mechanisms such as photo reactivation, nucleotide excision repair, and the SOS system, an overwhelming accumulation of dimers leads to erroneous base substitutions, ultimately culminating in cellular demise (Benson, 2001; Tripathi et al., 2013; Tripathi et al., 2018).

2. Materials required:

1. Petri dishes
2. Nutrient agar medium
3. Sterile swabs
4. Microorganisms (e.g., bacteria or fungi)
5. UV light source
6. Stopwatch
7. Marker pen

3. Procedure:

1. Prepare nutrient agar plates according to standard protocols and let them solidify.
2. Divide the agar plates into two groups: Control and UV-exposed.

3. Inoculate the control group with the selected microorganisms using a sterile swab. Label the bottom of the plates to distinguish control from UV-exposed.
4. For the UV-exposed group, set the agar plates for a predetermined amount of time at a specific distance from the UV light source.
5. Record the time of UV exposure accurately using a stopwatch.
6. After UV exposure, incubate all plates at the right temperature and conditions for the microbial growth.
7. Monitor and record the growth of microorganisms on both control and UV-exposed plates at regular intervals (e.g., 24, 48, and 72 hours).
8. Measure and record the diameter of microbial colonies using a ruler or caliper.
9. Analyze and compare the growth patterns and colony sizes between the control and UV-exposed groups.
10. Repeat the experiment with multiple trials to ensure reliability and consistency of results.
11. Document all observations, data, and conclusions obtained from the experiment.

4. Precautions:

1. Limit exposure to UV radiation by using appropriate shielding and protective equipment such as UV-blocking goggles and gloves.
2. Handle UV sources carefully to prevent accidental exposure or breakage.
3. Ensure the working area is well-ventilated to mitigate potential ozone production from UV sources.
4. Use UV-sensitive microorganisms in a controlled environment to observe growth effects.
5. Monitor exposure time and intensity of UV radiation to control experimental conditions.
6. Conduct experiments under controlled temperature and humidity to assess UV impact consistently.
7. Ensure UV exposure does not affect experimental setup integrity or material compatibility.
8. Dispose of contaminated waste and materials following recommended safety protocols

5. References:

1. Tripathi, K., Kumar, N., & Abraham, G. (2018). The role of photosynthetic microbes in agriculture and industry, Nova Science Publisher, USA.
2. Benson, H. J. (2001). *Microbiological applications: A laboratory manual in general microbiology* (8th ed.). McGraw-Hill.
3. Tripathi, K., Sharma, N. K., Kageyama, H., Takabe, T., & Rai, A. K. (2013). Physiological, biochemical, and molecular responses of the halophilic

cyanobacterium *Aphanothece halophytica* to Pi-deficiency. *European Journal of Phycology*, *48*(4), 461–473.

4. Prescott, L. M., Harley, J. P., & Klein, D. A. (2005). *Microbiology* (6th ed.). McGraw-Hill.
5. Harm, W. (1980). *Biological effects of ultraviolet radiation*. Cambridge University Press.
6. Sinha, R. P., & Häder, D. P. (2002). UV-induced DNA damage and repair: A review. *Photochemical & Photobiological Sciences*, *1*(4), 225–236.
7. Srivastava, Y., Tripathi, S., Mishra, B., & Sangwan, N. S. (2022). Cloning and homologous characterization of geranylgeranyl pyrophosphate synthase (GGPPS) from *Withania somnifera* revealed alterations in metabolic flux towards gibberellic acid biosynthesis. *Planta*, *256*(1), 4.
8. Reddy, Y. P., Yadav, R. K., Tripathi, K., & Abraham, G. (2019a). Isolation and characterization of high temperature tolerant mutant from the cyanobacterium *Anabaena doliolum. Journal of basic microbiology*, *59*(3), 314-322.
9. Reddy, Y. P., Yadav, R. K., Tripathi, K. N., Borah, A., Jaiswal, P., & Abraham, G. (2019b). Industrially important biomolecules from cyanobacteria. *A Handbook on High Value Fermentation Products-Human Welfare II. John Wiley & Sons*, 147-164.
10. Kageyama, H., Tripathi, K., Rai, A. K., Cha-Um, S., Waditee-Sirisattha, R., & Takabe, T. (2011). An alkaline phosphatase/phosphodiesterase, PhoD, induced by salt stress and secreted out of the cells of Aphanothece halophytica, a halotolerant cyanobacterium. *Applied and Environmental Microbiology*, *77*(15), 5178-5183.