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Influence of temperature and light intensity on growth of symbiotic cyanobacteria isolated from cyanolichens

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ABSTRACT

Axenic cultures of symbiotic cyanobacterial isolates *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29) and *Nostoc* sp. (NTY30) were subjected to different temperature and light intensity. Among four different temperature set, 20°C showed maximum growth rate in all the three symbiotic cyanobacterial isolates except NTK30 and different light intensity tested no significant growth obtained.

KEYWORDS

Lichens;
Cyanobacteria;
Temperature;
Light;
Growth.

INTRODUCTION

Microorganisms modify their biochemical composition in response to the environmental factors including nutrient availability, light, temperature and salinity. The effect of salinity stress in combination with variable temperature and light intensity influence the growth[12,18]. The changes in rates of respiration and net photosynthesis of lichen dominated system especially in *Stereocaulon paschale* (L) Hoffm in relation to temperature, moisture. The temperature optimum for net photosynthesis about 20-30°C and maximal rate of net photosynthesis are developed at low levels and the relative light requirement is 1000μE.m^{2}.s^{-1}[8]. Physio-chemical profiles describing the relationship between growth and environmental factors especially irradiance flux, density and temperature is important in the evaluation of micro algae and cyanobacteria for biomass production, as well as for their general characterization[9]. This investigation reveals that the cyanobacterial species isolated from cyanolichens were tested for two different parameters for their survival effect under stress condition. Because these organisms isolated from different and unique environment, hence it is essential to find the ability to withstand and grow in the stress condition separately so this is the base line study for survival and growth stability of cyanobacteria isolated from cyanolichens was reported.

MATERIALS AND METHODS

Isolation, identification and estimation of growth of symbiotic cyanobacteria

Small section of cyanolichen thallus was dipped in 0.1% mercuric chloride solution and repeatedly washed with sterile distilled water, and used for isolation of symbiotic cyanobacteria[15]. Sections of 30-40μm thickness were cut with a microtome, placed in 6cm petri dishes on BG11 medium containing 1.5% agar[1,16,23] and incubated at 20°C under continuous light at 2,000lux (Osram, universal white, fluorescent light, 40 W). After

Regular Paper

growth of cyanobiont were observed within the disintegrating thallus sections. They were transferred to fresh agar plates and incubated under the same conditions. Colonies of the cyanobiont were identified using the taxonomic publications of Geitler (1932), Desikachary (1959) and Starmach (1966). BG11 medium was used for cultivation of symbiotic cyanobacteria[16]. Culture medium was provided with proper light (2000lux) source. After fifteen to twenty days of incubation period homogenous culture was obtained thus used as inoculum for further physicochemical studies. Standard concentration of ingredients were taken to prepare medium and dispensed in to 100ml conical flasks. The flasks were subjected to different temperature ranges (15, 20, 30, 37 and 40°C) and light intensity levels (Blue 091-095Lux, Green 098-104Lux, and Red 167-168Lux), separately kept as triplicates. White light (2000Lux) was used as control.

RESULT

Effect of temperature

Three symbiotic cyanobacterial isolates were subjected to different temperatures such as 15, 20, 30 and 40°C. All the three cyanobacterial isolates tolerated all the tested temperatures. The maximum growth rate was observed at 20°C for *Aphanocapsa* sp. (NTK28) and *Nostoc* sp. (NTY30), where as 15°C maximal growth rate was observed in *Nostoc* sp. (NTK29) (Figure 1 a-c). The maximum chlorophyll 'a' (µg/ml) content was 25.260, 39.153, 51.783 (*Aphanocapsa* sp. (NTK28), 18.563, 46.735, 50.502 (*Nostoc* sp. NTY30) at 20°C

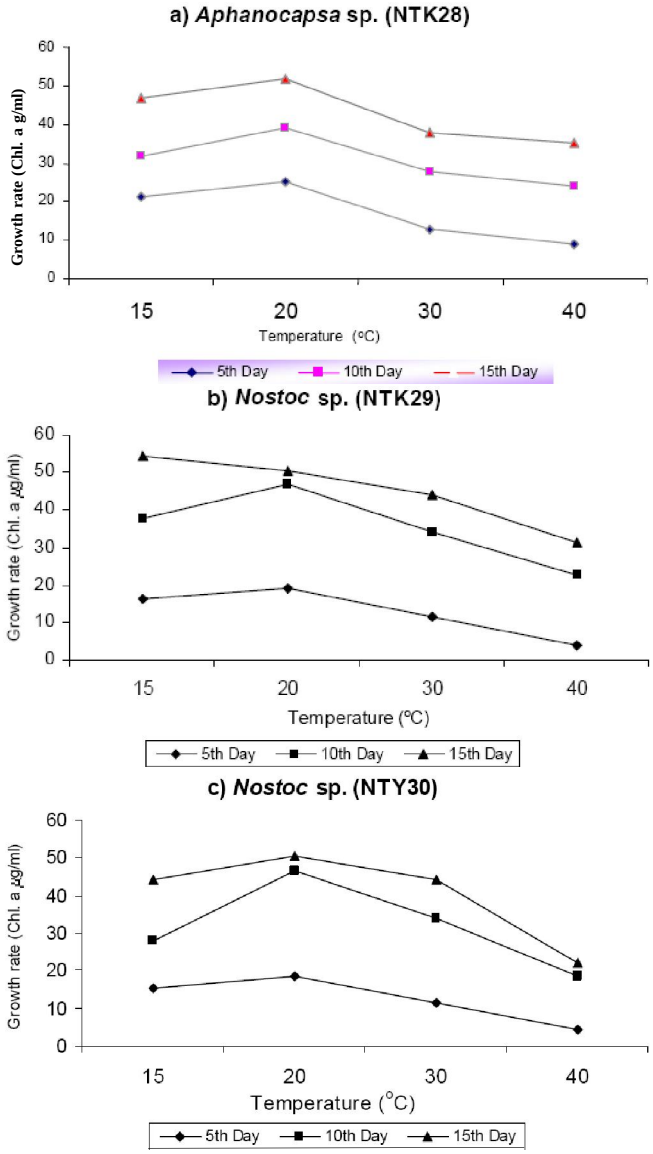

Figure 1: Effect of temperature on growth of cyanobacteria

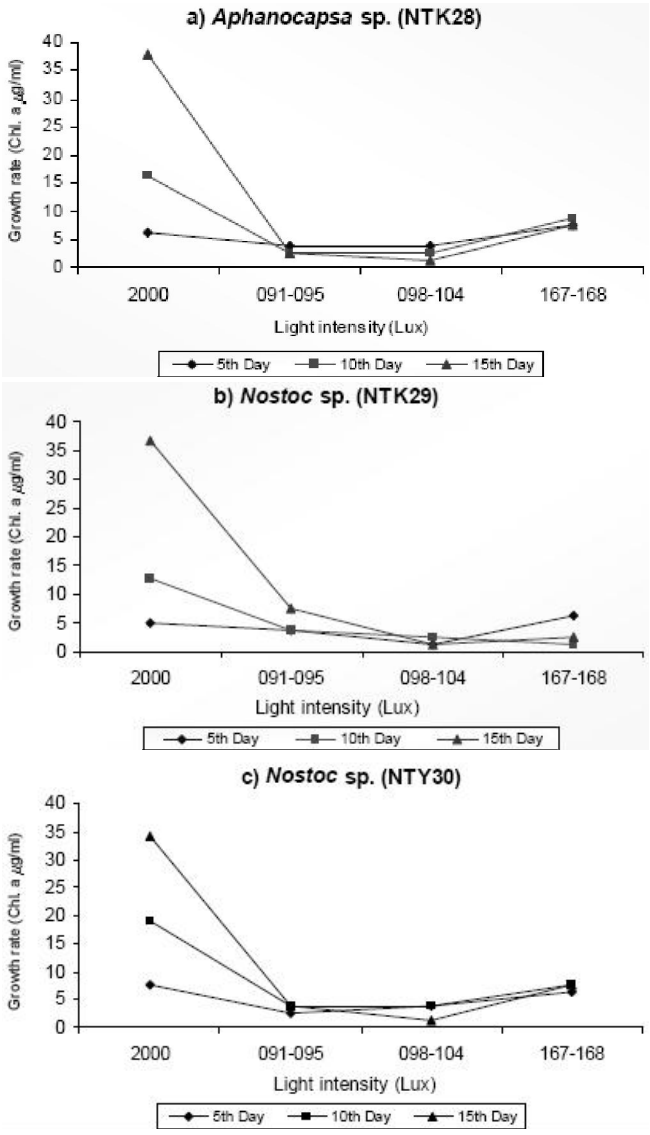

Figure 2: Effect of light intensity on growth of cyanobacteria

and 16.419, 37.89, 50.502 (*Nostoc* sp. (NTK29) at 15°C on the 5, 10 and 15th day respectively. With the increase in temperature, the growth rate gradually decreased in all the three symbiotic cyanobacterial isolates.

Effect of light intensity

The three symbiotic cyanobacteria *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29) and *Nostoc* sp. (NTY30) were exposed to different light intensities such as 91-95lux (Blue light), 98-104lux (Green light) and 167-168lux (Red light). When compared with control (organism exposed to white light 2000lux), no significant growth difference (in terms of chlorophyll 'a') was observed (Figure 2 a-c).

DISCUSSION

Growth of symbiotic cyanobacteria on different temperature and light intensity was analyzed in four different temperature conditions, namely 15°C, 20°C, 30°C, and 40°C. *Aphanocapsa* sp. (NTK28) and *Nostoc* sp. (NTY30) showed maximum growth in 20ºC (about 51.783µg/ml and 50.502µg/ml chlorophyll a content) in fifteenth day, where as *Nostoc* sp. (NTK29) showed maximal growth at 15°C (about 54.309µg/ml) Optimal growth-temperature for these symbiotic organisms were 15-20°C. similarly when the isolates exposed to different light intensities such as (Blue 91-95Lux, Green 98-104Lux, and Red 167-168Lux). No significant growth was observed among three organisms, even though *Aphanocapsa* sp. (NTK28) and *Nostoc* sp. (NTY30) showed some amount of growth in the later days (chlorophyll a content at the maximum 7.578µg/ml) on fifteenth day in red light.

Cyanobacteria are famous for massive occurrence in eutropic waters. Because of the high phytoplankton-biomass concentrations and the presence of other suspended matter; fluctuations in light intensity is prevalent at this zone. For this reason the study of both light periodicity and light irradiance is of direct ecological relevance[3,11]. It is demonstrated that growth and photosynthetic activity of phytoplankton and cyanobacteria were affected by higher temperature[10]. There are several physical, chemical and biological parameters, which change at the time of temperature and light intensity variations, but temperature is a parameter that can be easily manipulated and whose effect can be easily studied both in natural samples and in cultures. Tilzer (1987) revealed that higher yield of biomass can be achieved by effective light harvesting for photosynthesis and maintenance of energy requirements at low mean irradiance. Although in the present study, no significant growth in terms of chlorophyll a' was observed using different light sources (blue, green and red) no experimental reports on similar aspects of symbiotic cyanobacterial isolates from lichens are available. It is reported that the direct temperature affects the photosynthetic capacity (P_{max}), specific respiration and growth rate of bloom-forming cyanobacteria (*Anabaena, Aphanizomenon, and Microcystis*[17]. *Nostoc muscorum* was reported to register least growth in low intensity (1500lux) and increased growth rate at 3000lux[7]. Under light limited condition in continuous culture of *Anabaena* sp. and *Aphanizomenon flos–aquae, Anabaena* sp. showed higher affinity and steady state of nitrogen fixation activity than that of *Aphanizomenon flos-aquae*[13]. The different between the two species in their acclimatory response is discussed in terms of a species-specific alteration of the PSI: PSII stoichiometry. Moreover with the species-specific modulation of the accessory pigments, such an acclimation would provide a biochemical basis for the observed physiological differences. The monoculture results were used to differentiate the niches of two species and it was suggested that *Aphanizomenon* would competitively displace *Anabaena* under N_2-fixing, light limited condition. However, when both species were grown together, *Anabaena* became dominant and seemed to be the superior competitor for light. Another study revealed that the changes in plasma membrane may act as primary low temperature sensor in *Synechocystis*[5,6,20-22]. Altering experimentally the molecular order of thylakoid membranes affected dramatically the temperature range over which genes of heat shock proteins get activated[5,6,20-21]. It was also reported that the binding of stress protein in lipid matrix rigidify membranes[5,6,20,21]. Thereby, it may rapidly stabilize them under stress readjustment of lipid molecular species. Pretreatment of organisms with salt and temperature induces oxidative damage to the organisms[18].

Regular Paper

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