Isolation and identification of UV absorbing compounds from cynobacteria *(Synechocystis)* of District Mardan

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Abstract- Blue green algae (also known as cyanobacteria) are photosynthetic prokaryotes found in a verity of environments. They may be aquatic, epiphytic, rhizosoheric, endophytic, found in fresh water or salty water or on damp soil. Biotechnological applications of cyanobacteria are many including their use as a source of UV absorbing pigments. During current study, *Oscillatoria, Synechocystis, Gloeocapsa, Nostoc, Cyanothece* and *Microcystis* were isolated from different locations of gujar garhi using a modified version of BG11. The strains were identified by colony morphology and light microscopy. The isolates were grown in the presence of tube light and sunlight and screened for UV absorbing compounds. Though all the strains produced UV absorbing compounds but only negligible or no absorbance in the UV-A and UV-B regions was recorded. Being the most harmful component of UV light due to their ability to reach the earth atmosphere, our aim was to induce production of compounds in the isolated cyanobacteria which can screen these components of UV radiation. Exposure to UV light was an excellent force inducing the isolates to produce UV-A and UV-B absorbing compounds. All the isolates produced significant quantities of phenols and flavonoids in both sunlight and tube light. However, *Synechocystis, Gloeocapsa* and *Oscillatoria* produces higher quantities of flavonoids than *Cyanothece, Nostoc*, and *Microcystis*. Production of phenols and flavonoids is greatly induced upon exposure of the isolated cyanobacteria to UV. Phenols and flavonoids are important for their role in the antioxidant system of cyanobacteria. Additionally, the also absorb significantly in the UV-A and UV-B regions as HPLC fractions containing phenols or flavonoids were efficient in absorbing in these regions. It may be concluded that cyanobacterial isolates naturally produce UV-C absorbing compounds, however UV-B and UV-A absorbing compounds induced by UV light exposure. Absorbance in these region is positively correlated with the production of phenols and flavonoids which are induced by exposure to UV light.

Index Terms- (Cyanobacteria, Synechocystis, UV absorbing compounds, UV Radiations, HPLC)

I. Introduction

Blue green algae are photosynthetic prokaryotes found in a verity of environments. They may be aquatic, epiphytic, rhizosoheric and endophytic. These cyanobacteria can be found in fresh water, marine water and in moist places. They are small

creature include unicellular, colonial or filamentous organisms. They are important companion of higher plants undergoing symbiotic association with a number of higher plants, providing their hosts with nitrogen and other nutrients or phytoharmones, as we know that cyanobacteria are atmospheric nitrogen fixers thus they transfer it into their partner where both partners are benefited (Whitton et al., 2012). These blue green algae are important to aquatic biology of both fresh and marine animals. Cyanobacteria convert sunlight by photosynthesis to release oxygen into water. They are also important in health and food industry. Algae are the most useful organism in the world as they consume most of CO2 from the air and release most amount of oxygen which keep us alive and are being used in many industries and applications. These tiny algae are important source of algal biofuels. Besides, other important products of cyanobacteria include carotenoids, phycobilins, fatty acids, vitamins, sterols and many bioactive compounds, which have been used for human health and in pharmaceuticals. Anti-cellulite and Alguronic acid are also extracted from algae which are used in cosmetics. Antivirals and antifungals are also present in most of cyanobacterial species which are being currently commercialized and used in pharmaceutical industries.

UV radiations has both the beneficial and harmful effects to human health. UV radiation is responsible for bone strengthening because they produce the bone strengthening vitamin D. It seems that those who get higher sun there are more vitamin D in their body and those who get lower sun there are less vitamin D. Vitamin D is known to control calcium metabolism in human and hence play important role in bone strengthening and growth (Backer et al., 2013). On the other hand, over-exposure to ultra violet radiation is associated with sun burn, freckling and cancer etc. Also, ultra violet photons harm the DNA molecules of living organism which results in harmful modifications in genes. Peoples with missing lens or replacement lens can see some ultra violet wavelengths (Hambling et al., 2002). It has been recognized many years ago that UV-B radiation cause skin crythema (Skin burn) and prolonged exposure to UV-B radiation can lead to DNA damage, immunosuppression and sometimes may also lead to cancer (Boelen et al., 2002).

UV radiations can also effect algae and cyanobacteria (blue green algae). Many biochemical and biological process which has been reported to be effected by UV radiation include nitrogen metabolism, carbon dioxide uptake, photosynthetic O_2 production and growth (Sinha et al., 2007). Moderate ultraviolet radiation effect photosynthesis and N_2 fixation in *Anabaena* species (Tedett et al., 2006). Ultraviolet radiations mainly divided into three regions including UV-A, UV-B and UV-C. UV-B radiation generally decrease chlorophyll content and photosynthesis in cyanobacteria which results in lower biomass. UV-B radiation can damage several biological and biochemical processes in cyanobacterial cells.

Different organisms produce different types of compounds which protect them against the harmful UV radiation. Cyanobacterial (Blue green algae) are known to produce a number of secondary metabolites and pigments which protect their cells against the harmful influence of UV radiation.

In cyanobacteria, a number of ultraviolet (UV) absorbing compounds including mycosporine amino acid and Scytonemin are found which help them grow in the presence of UV radiation. Mycosporine like amino acids are ultra-violet absorbing compounds which are photo protective agent against-UV radiation in aquatic organisms (Rastogi et al., 2010). MMA (Mycosporine- amino acids) absorb ultraviolet radiation in the range of 310-360 and believed to acting as sunscreens. Cysteine type of MMA is produced in most of marine organisms (Sinha et al., 1998). MMA are small (≤ 400 Da). They have no color and are water soluble and are characterized by cyclohexanene. They have very strong ultra-violet absorption in the range of 310 and 362 nm. In water soluble components the cyclohexanone and cyclohexeniminechromophor is UV captivates. Different amino acids incorporates results in a variety of twenty micosporine amino acids (Cockell et al., 2000). Cyanobacterial carotenoids such as lutein, caloxanthin, oscillaxanthin, canthexanthin and polyphenolic compounds such as Scytonemin and mycosporine amino acid are used in sun blocking cream.Several natural and synthetic products are used to make sunscreens which are applied to human skin in order to avoid UV demage. Sun screens is a type of gel, lotion, spray that absorbs sun harmful radiations or reflect these UV rays from the skin of humans exposed to sunlight. These sunscreens contain UV absorbing substances used for the human's skin to protect them from harmful UV radiations (Lowe et al., 1997). Substances used in these sunscreens may be organic or inorganic. Organic substances include benzophenones, triazines, benzotriazoles and methoxydibenzoylmethane, while inorganic substances include titanium dioxide and zinc oxide (Zhang et al., 1998).

Current project was designed to screen local cyanobacteria for UV absorbing compounds and identify such compounds. For this purpose local cyanobacteria were isolated, cultured and screened for absorbance in UV-A and UV-B regions. HPLC fractionation and LC-MS/MS analysis was then performed to identify the compounds involved in absorbing the harmful UV radiation.

II. MATERIAL AND METHODS

A. Sampling Cyanobacteria

Different samples of cyanobacteria were collected randomly from moist places and ponds present in district Mardan. Forceps were used to collect algal specimens and stored at 4 ℃ for further experiments.

B. *Light Microscopy*

Microscopy of samples were done with the help of a light microscope. The slides were then observed under 10x, 40x and 100x objective lenses to identify the specimens.

C. Ultra violet scanning

Supernatant of both BG11 and biomass extract in acetone were scanned for absorbing radiation in the range of 200 nm to 800 nm using a UV/vis spectrophotometer (PerkinElmer lambda 25 spectrophtotometer).

D. Samples incubation in sun and tube lights

Samples were grown in the presence of sun light and tube light to evaluate the effect of different light sources on the growth and production of UV absorbing compounds by the isolates. The supernatant and biomass crushed acetone were scanned for absorbing in the UV range of the spectrum at intervals of 1 week, two weeks and three weeks of incubation.

E. Cyanobacterial growth under UV light

Samples were grown in broth for two weeks and then exposed to strong ultra violet radiation for different duration of time i.e. for one hour, three hours, six hours and twenty four hours.

F. Growth measurement

Growth measurement was done after incubating the samples in sun light and tube light for three weeks. The cultures were centrifuged at 14500 RPM for ten minutes, the supernatant were discarded and the pellets were weighed.

G. Flavonoids determination

Flavonoids were determined in the cultures of isolated cyanobacteria by using colorimetric assay as described by Lillian et al, (2007). The quantity of flavonoids in the samples were calculated from standard curves and were expressed in mg of equivalent catechol/g.

H. Phenol Determination

Phenols were determined in the cultures of isolated cyanobacteria. Folin reagent were used as a blank. Their OD were recorded at 650 nm.

A. Isolation and characterization of algae

Synechocystis was found attached to a substratum in fresh water were isolated. Isolation and purification were carried out through a two steps procedure. Firstly, samples of algae were spreaded on plates and then streaked for purification. Algal growth appeared on plates after incubation of 10-15 days at

I. Statistical Analysis

Data was analyzed statistically for significance using ANOVA and Duncan multiple range test ($p = 0.05$) through SPSS for windows ver 16.0.

J. HPLC fractionation

The samples showing high absorbance in the UV-A and UV-B regions were subjected to fractionation by HPLC equipped with a reverse phase column, isocratic pump and fraction collector. All the peaks were collected and stored for further processing at 4 C.

K. LC-MS

For the identification of UV absorbing compounds, fractions of HPLC were subjected to ESI-MS/MS (LTQ XL, Thermo Electron Corporation, USA), for this purpose direct injection method were used (Steinmann et al ., 2011). Methanol and acetonitrile at the ratio of [80:20 (v/v)] were used as a solvent. Mass range in ionization mode were selected from 50 to 1000 m/z. on the basis of parent molecular ion nature collision dissociation energy were kept in range of 10-45 during MS/MS. Temperature of capillary were kept at 280 °C whereas sample flow rate were regulated to 8 µL/min. to study ionization, ion transfer and optimum signal, MS parameter for each compound were adjusted. This process were done through filling analytes and rotating parameters. For all the analytes source parameters were same. The acquired ESI-MS/MS data was analyzed using manual, Xcalibur (Xcalibur 3.0). ChemDraw (ChemDraw Ultra 8.0) software was used for structural elucidation and then compared with online published data.

III. RESULTS

room temprature. Cynobacterial growth were appearred after 20-25 days. Tentative analysis of their morphology was done. Purified strain were grown in BG11 broth for 25 days. After sufficient biomass in broth strain were then grown in sunlight and tube light for different i.e 1 week, 2 weeks and three to check effect of incubation time on isolated strain. After every week their supernatant were scanned to check UV absorbing compounds, to measure growth and secondary metabolites. Similarly isolated strain were also grown under UV light for different duration of time i.e for 1, 3, 6 and 24 hours to check effect of UV light on growth, UV absorbing compounds and secondary metabolites.

B. Light microscopy

Unicellular *Synechocystis* sp SC1 were observed under light microscope (Figure 4.1). It was observed that *Synechocystis* sp SC1 have three dimensional structure and spherical unicells without mucilaginous sheath. Cells of *Synechocystis* sp SC1 form colonies.

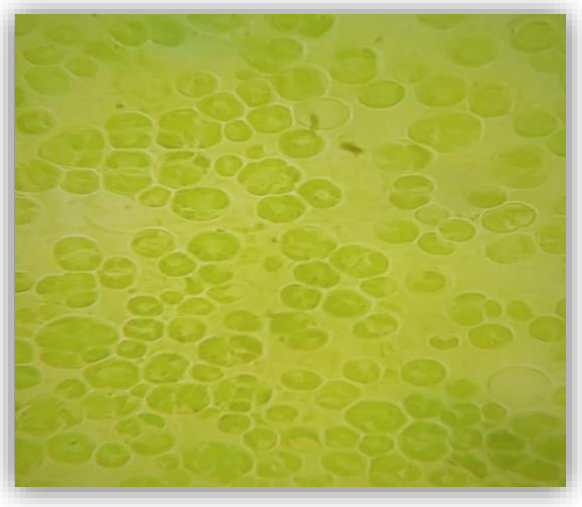


Fig 4.1 light microscopy of *Synechocystis*

Now it is the time to articulate the research work with ideas gathered in above steps by adopting any of below suitable approaches:

C. UV Absorbance of Synechocystis

Synechocystis sp SC1 was grown in tube light and sunlight for one week and the culture supernatant and acetone extract of biomass were scanned for absorbance in different regions of UV including UV-A, UV-B and UV-C using a spectrophotometer. Culture supernatant obtained from culture grown in tube light for a week showed absorbance in the UV-C region. Absorbance in the UV-A and UV-B regions was only negligible (Figure4.3A). In UV-B region absorbance peaked (0.49) at 286 nm, while in UV-A region greatest absorbance recorded was (0.46) at 334 nm (Figure 4.3A). Acetone extract of the biomass had absorbed radiation in UV-B and UV-A regions. In UV-B region greatest absorbance was (2.05) at 299 nm. There was no absorbance in the UV-A region (Figure 4.3B). Culture supernatant of *Synechocystis* sp SC1 grown in the presence of sun light showed similar absorbance pattern as was noted in case of sunlight (Figure 4.3A). However, the acetone extract of biomass showed less absorbing pattern as compared to the tube light grown cultures. Less absorbance in the UV-C region was recorded. In UV-A region the absorbance peaked (0.936) at 320 nm (Figure 4.3B). In UV-B region, the greatest absorbance recorded was (0.36) at 388 nm.

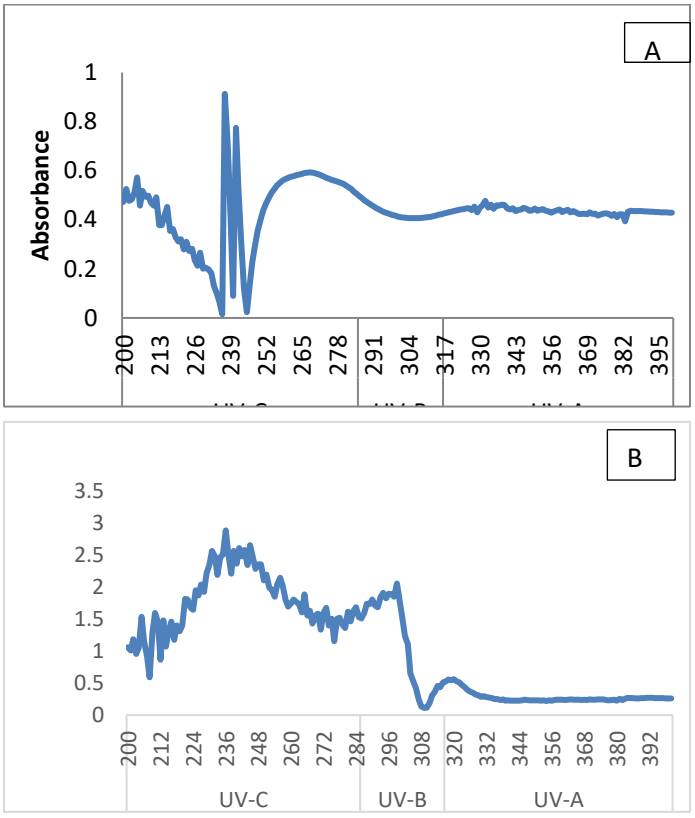


Figure 4.2. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 1 week exposure to tube light.

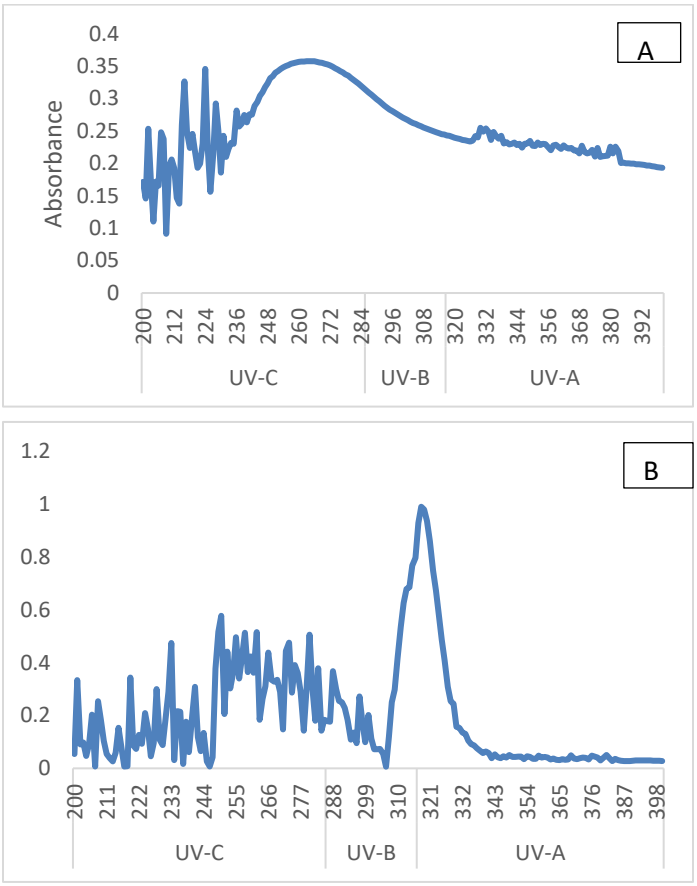


Figure 4.3. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 1 week exposure to sun light

To check the effect of incubation time on UV absorbance, culture of *Synechocystis* sp SC1 grown for two weeks was subjected to UV absorbance scan. It can be seen that culture supernatant of tube light exposed cultures of *Synechocystis* sp SC1 produced an absorbance scan quite different from the one week old cultures. Less absorbance were noted in UV-C region. There were no absorbance in UV-B and UV-A regions (Figure 4.4A). Similarly, acetone extract of the cyanobacterial biomass also showed different pattern of absorbance. The greatest absorbance was noted in UV-C region. In UV-B region, absorbance peaked (0.55) at 281 nm (Figure 4.4B). This absorbance was clearly different from the absorbance pattern noted for culture allowed to grow for one week only. Culture supernatant of sun light exposed cultures of *Synechocystis* sp SC1 produced an absorbance scan similar to tube light exposed culture (Figure 4.5A). Acetone extract of the cyanobacterial biomass showed greatest absorbance in UV-C and UV-B regions. In UV-B regions the greatest absorbance recorded was (6.3) at 289 nm as compared to *Synechocystis* sp SC1 culture allowed to grow for one week only.

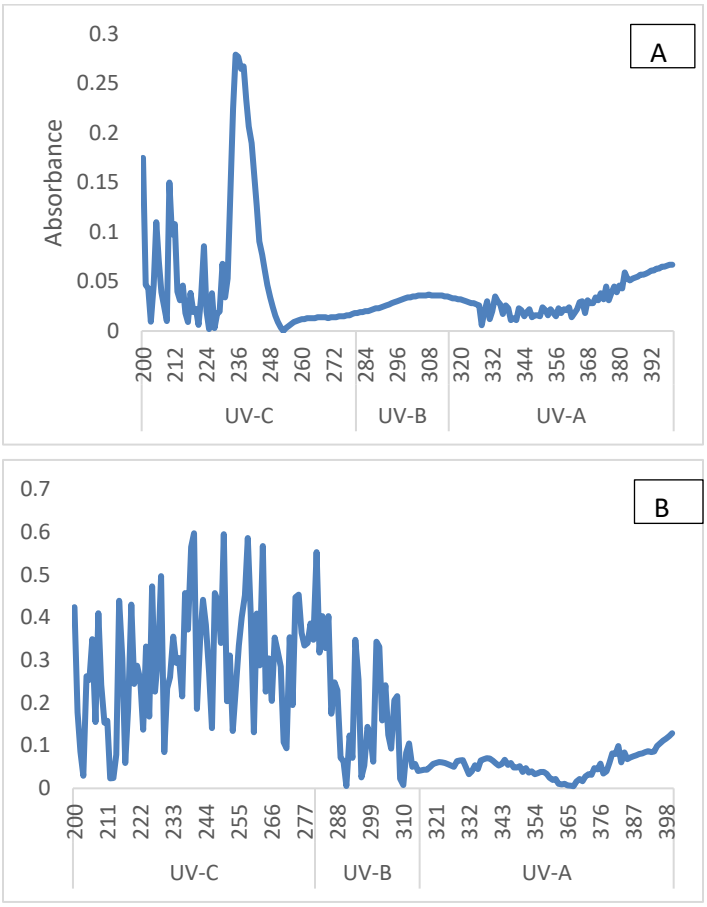


Figure 4.4. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 2 weeks exposure to tube light.

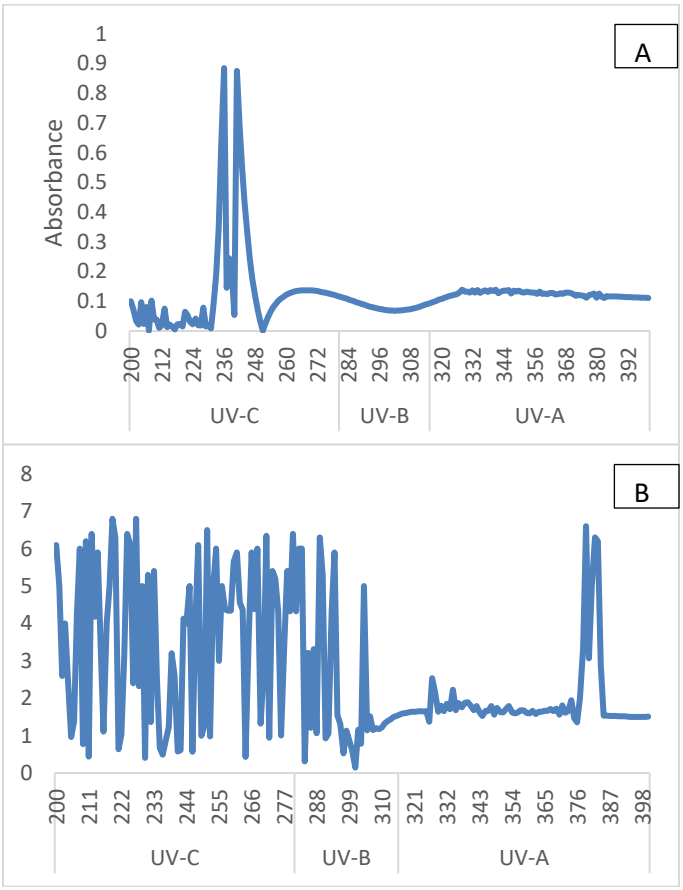


Figure 4.5. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 2 weeks exposure to sun light.

Synechocystis sp SC1 Culture grown for three weeks subjected to UV absorbance to check the effect of incubation time. It can be seen that culture supernatant of tube light exposed cultures of *Synechocystis* sp SC1 produced an absorbance scan different from one week and two weeks old cultures (Figure 4.6A). Interestingly, acetone extract of the cyanobacterial biomass showed less absorbance in UV-C region only and no absorbance were recorded in UV-A and UV-B regions of spectrum. Culture supernatant of *Synechocystis* sp SC1 grown in the presence of sun light showed similar absorbance pattern as compared to one week old cultures (Figure 4.7A). However, the acetone extract of biomass showed less absorbing pattern as compared to the one and two week's old cultures (4.7B). In sun light grown culture, most of the absorbance was in the UV-C region of UV (Figure 4.7B). In UV-B region, the greatest absorbance recorded was (0.41) at 314 nm. In the UV-A region the absorbance peaked (0.79) at 316.

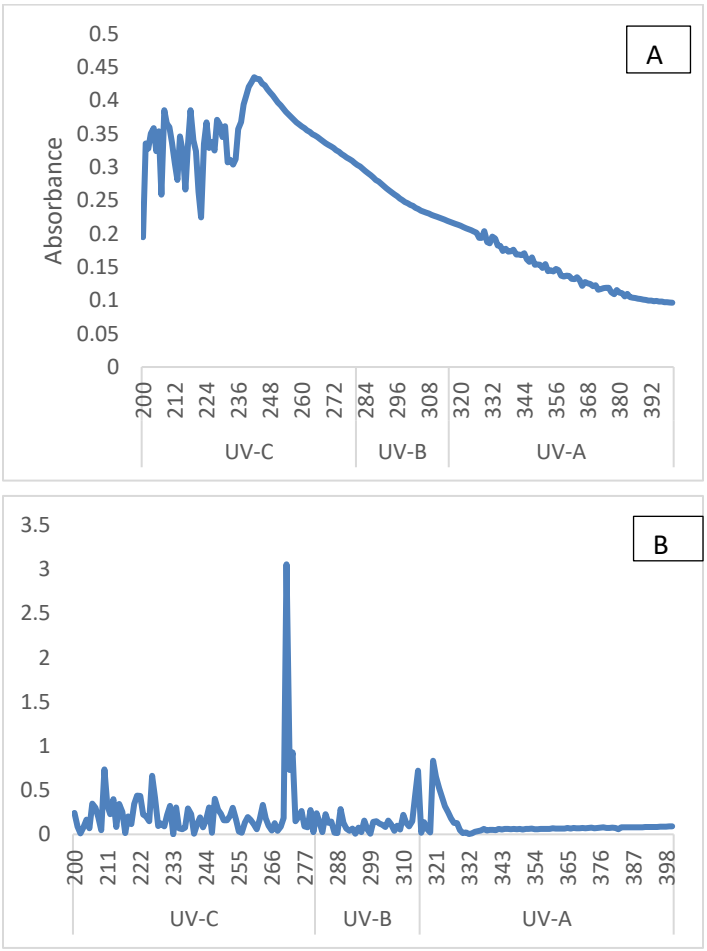


Figure 4.6. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 3 weeks exposure to tube light.

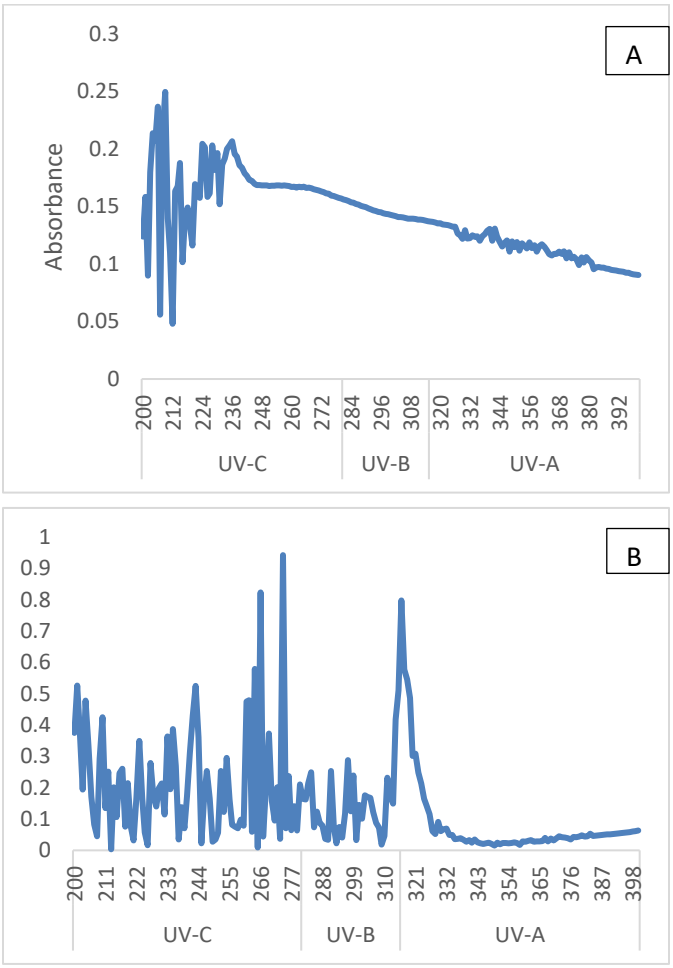


Figure 4.7. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 2 weeks exposure to sun light.

Effect of UV light on *Synechocystis's* ability to absorb UV light

Synechocystis sp SC1 was exposed to UV light for different duration of time i.e for 1 hour, three hours, six hours and twenty four hours, culture supernatant and acetone extract of biomass were scanned for absorbance in different regions of UV including UV-A, UV-B and UV-C using a spectrophotometer. Culture supernatant obtained from culture grown in UV light for one hour showed absorbance in the UV-C region. In UV-B and UV-A regions no absorbance were recorded (Figure 4.8A). Acetone extract of the biomass had absorbed radiation in all the three regions of UV (Figure 4.8B). In UV-B region, the greatest absorbance recorded was (6.57) at 290 nm and in UV-A region absorbance peaked (7.01) at 328 nm. Culture supernatant of UV light exposed cultures for three hours produced an absorbance

scan were similar pattern to the one hour old cultures (Figure 4.9A). Acetone extract of the biomass had absorbed radiation in all the three regions of UV (Figure 4.9B). In UV-B region, the absorbance peaked 6.9 at 308 nm and in UV-A region greatest absorbance recorded was 7.40 at 350 nm (Figure 4.9B). Culture supernatant obtained from culture grown in UV light for six hour produced an absorbance scan different from the one hour and three old culture (Figure 4.10A). Absorbance in UV-C region were recorded maximum, while in UV-B and UV-A no absorbance were recorded (Figure 4.10A). Acetone extract of the biomass had absorbed radiation in all the three regions of UV (Figure 4.10B). In UV-B region absorbance peaked (7) at 310 nm, while in UV-A region greatest absorbance was (7) at 330 nm. To check the effect of incubation time on UV absorbance, culture of *Synechocystis* sp SC1 grown for 24 hours under UV light was subjected to UV absorbance scan. Culture supernatant produced an absorbance scan similar to 3 hours old cultures (Figure 4.11A). Acetone extract of the biomass had absorbed radiation. In UV-B region greatest absorption recorded was (6.9) at 308 nm, while in UV-A region the absorbance peaked (7.40) at 350 nm.

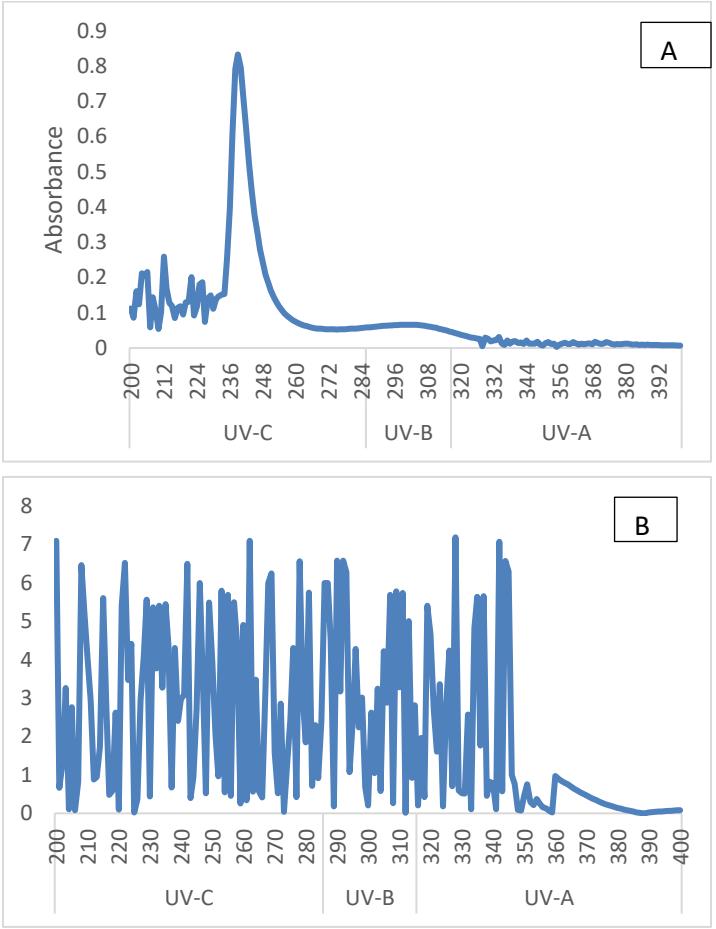


Figure 4.8. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 1 hour exposure to UV light.

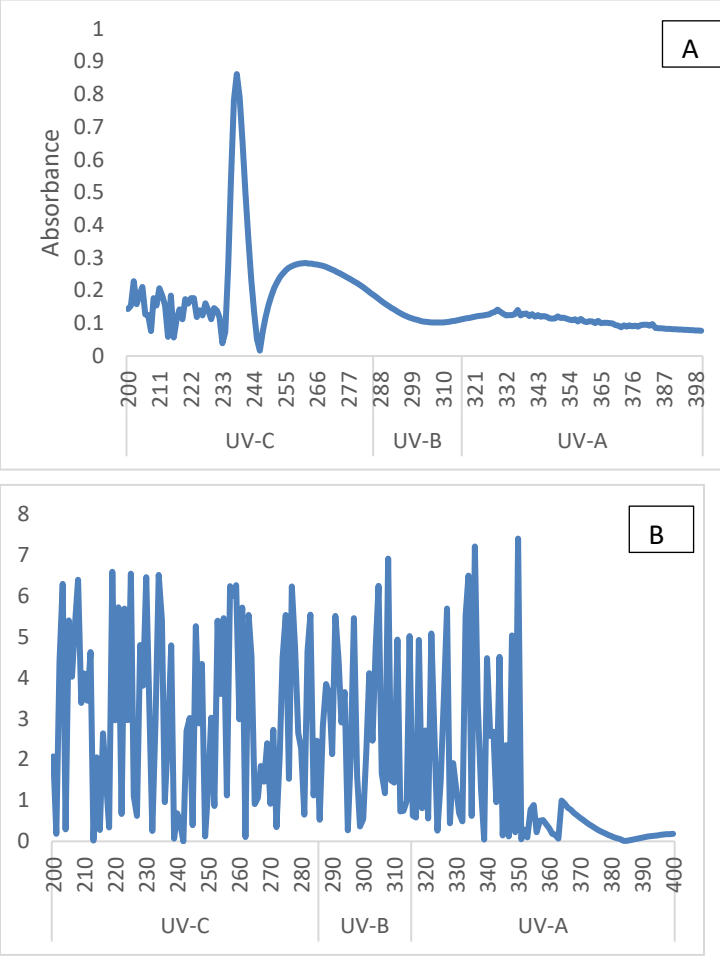


Figure 4.9. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 3 hours exposure to UV light.

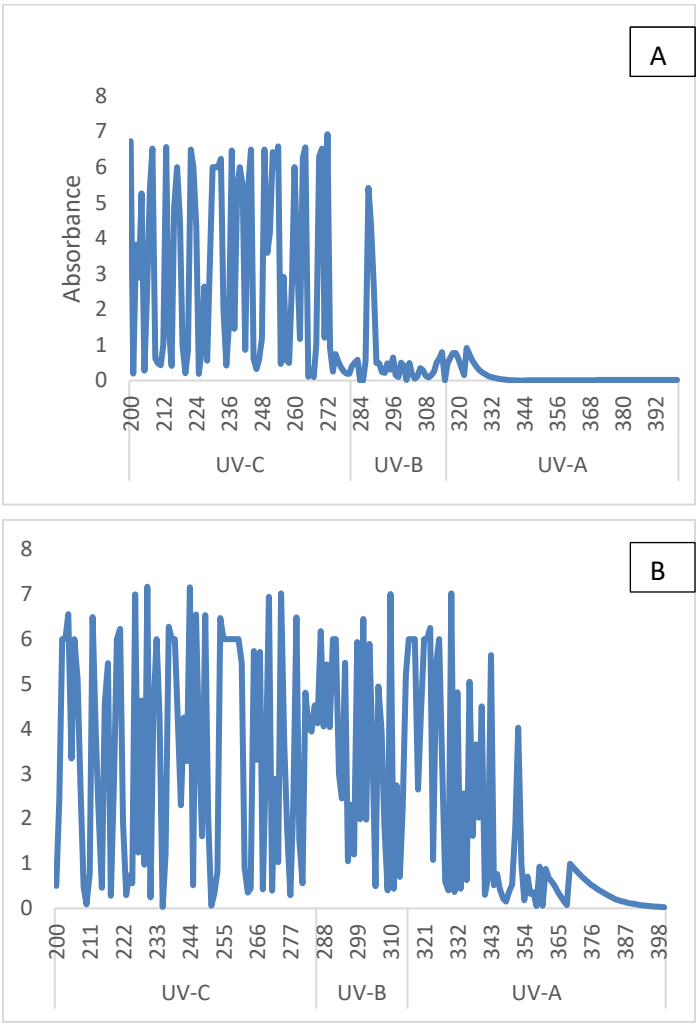


Figure 4.10. Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 6 hours exposure to UV light.

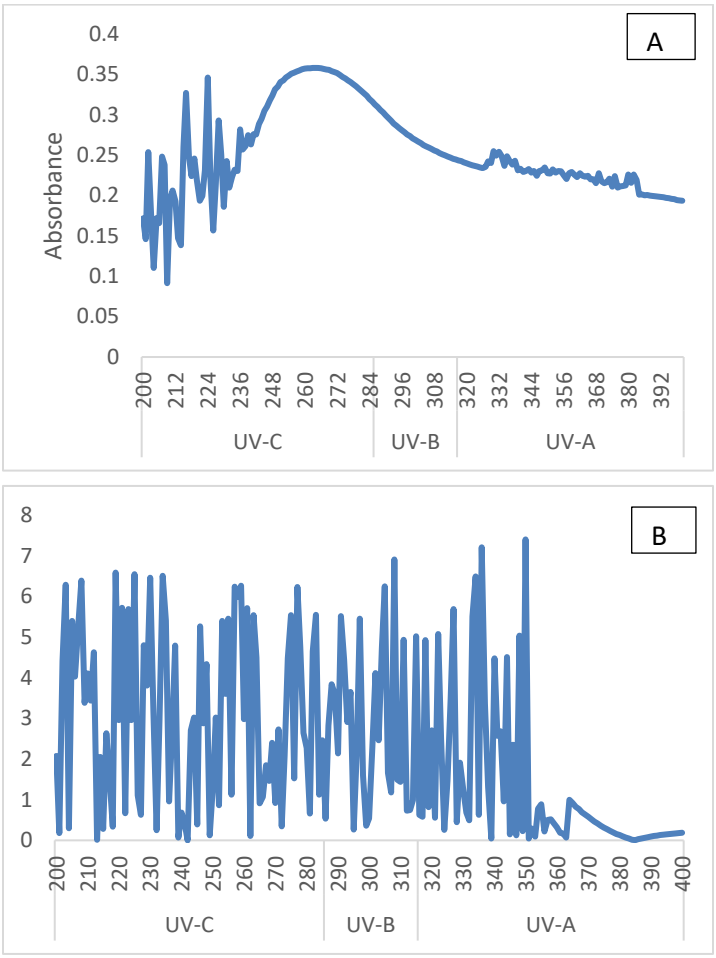
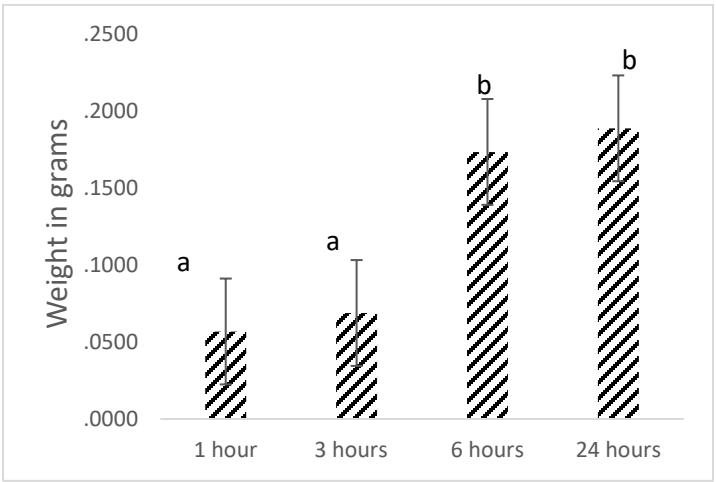


Figure 4.11 Absorbance in the UV-C, UV-B and UV-A region by *Synechocystis* sp SC1 culture supernatant (A) and acetone extract of its biomass (B) after 24 hours exposure to UV light.

Effect of different sources of light on the growth of cyanobacteria



After one week exposure of sun light and tube light, growth of *Synechocystis*sp SC1, were measured by using balance. Weight of the strains was recorded as mg mL^{-1}. For *Synechocystis* sp SC1 sun light was good source of light and the strain produced up to 2-fold more biomass than one week (Figure 4.12). Maximum growth were recorded in sun light grown *Synechocystis* sp SC1. After three weeks the biomass were decreased in *Synechocystis* sp SC1.

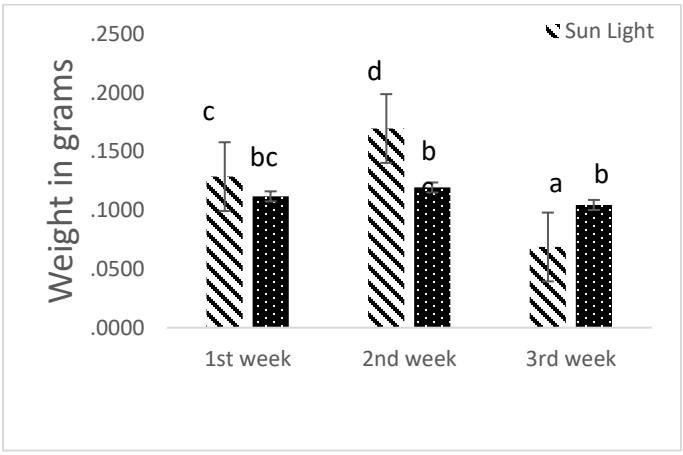


Fig 4.12. Measurement of growth in *Synechocystis* sp SC1 after three weeks. Different labels on the bars of same color indicate significant difference ($p<0.05$; Duncan test).

Growth of *Synechocystis* sp SC1 was measured after exposure to UV light for different duration i.e, for one, three, six and twenty four hours. Weight of the strains was recorded as mg mL^{-1}. In case of *Synechocystis* sp SC1 UV light was good source of light and their biomass increased gradually when exposed to UV for different duration of time (4.13).

Fig 4.13. Effect of UV exposure on the growth of *Synechocystis* sp SC1. Different labels on the bars indicate significant difference between means (p<0.05: Duncan test). .

Production of flavonoids by cyanobacteria

Synechocystis sp SC1 was grown in the presence of sunlight and tube light for different duration of time i.e for one week, two weeks and three weeks and then amount of flavonoids released in the cultures was measured. Flavonoids released were sharp (Figure 4.14).To check the effect of incubation time on flavonoids released, cultures were monitored after two weeks. Maximum production of flavonoids were recorded in *Synechocystis* sp SC1 (Figure 4.14).Gradual increase occurred in the production of flavonoids for two weeks. After three weeks determination of flavonoids were done *Synechocystis* sp SC1 produced higher quantities of total flavonoids when grown in tube light than the sun light culture (Figure 4.14).

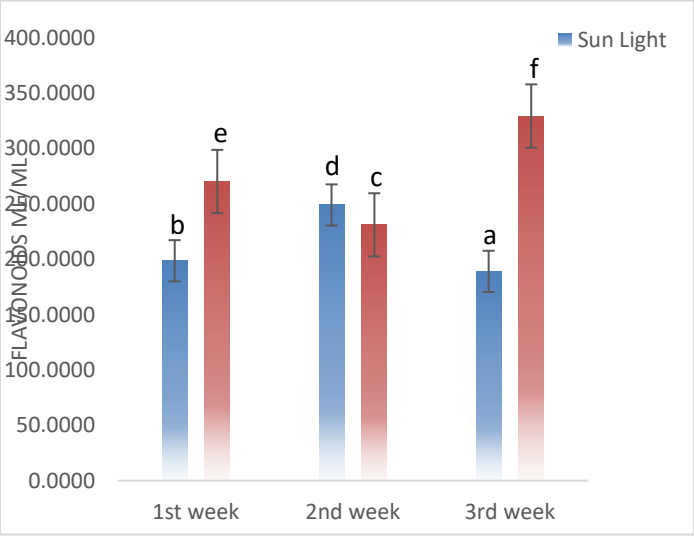


Fig 4.14. Determination of flavonoids in *Synechocystis* sp SC1 culture exposed to tube light and sun light for one week. Flavonoids were determined by colorimetric method after one week. Different labels on the bars of same color indicate significant difference (p<0.05; Duncan test).

Synechocystis sp SC were exposed to UV light for different duration of time i.e, for 1 hour, 3 hours, six hours and twenty four hours and then flavonoids released in the culture were determined by colorimetric method. There were gradual time dependent increase in the amount of flavonoids released into the *Synechocystis* sp SC1 for six hours and after six hours their flavonoids concentration were same when exposed to UV light for twenty four hours (Fig 4.15).

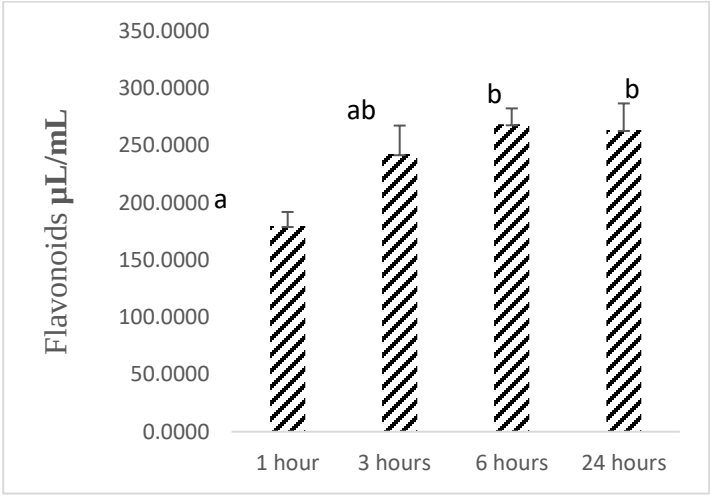


Fig 4.15. Effect of UV exposure on flavonoids of *Synechocystis* sp SC1. Different labels on the bars indicate significant difference between means (p<0.05: Duncan test).

Production of Phenol by cyanobacteria

Synechocystis sp SC1 were grown in the presence of sunlight and tube light for different duration of time i.e, for one week, two weeks and three weeks and then production of phenols in the cultures was measured. Sunlight was the most suitable source of light for greater production of phenols by *Synechocystis* sp SC1. After two weeks quantity of phenol in the cultures were measured. *Synechocystis* sp SC1 prosduced higher quantities of total phenols when grown in sun light than the tube light cultures (Figure 4.16). To check the effect of incubation time on the production of phenols strains were grown in sunlight and tube light for three weeks (Fig 4.16). Decrease in the production of phenols in all cultures were monitored (4.16).

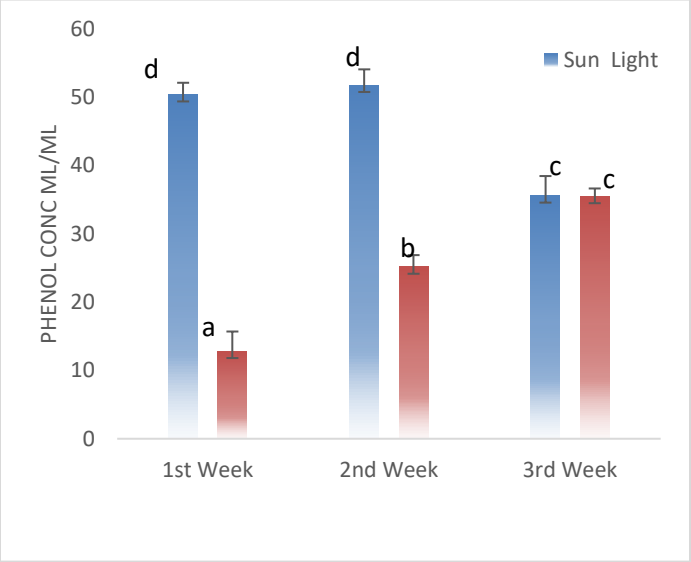


Fig 4.16. Determination of Phenol in *Oscillatoria*sp F1, *Synechocystis* sp SC1, *Gloeocapsa* sp S, *Nostoc* sp F2, *Cyanothece* sp SC2and *Microcystis sp*SC3 cultures exposed to tube light and sun light after one week. Different labels on the bars of same color indicate significant difference ($p<0.05$; Duncan test).

Synechocystis sp SC were exposed to UV light for different duration of time i.e, for 1 hour, 3 hours, six hours and twenty four hours and then phenol production in the culture were determined by colorimetric method. There were gradual time dependent increase in the amount of phenol released into the culture *Synechocystis* sp SC1when exposed to UV light for 1 hour, 3 hours, six hours and twenty four hours (Fig 4.17).

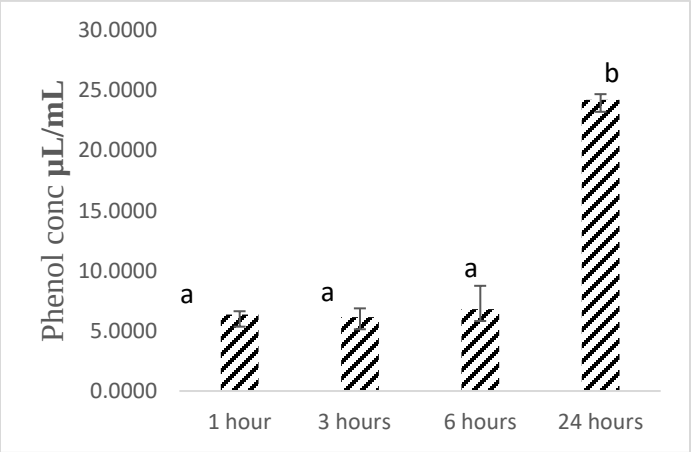


Fig 4.17. Effect of UV exposure on phenols of *Synechocystis* sp SC1. Different labels on the bars indicate significant difference between means ($p<0.05$: Duncan test)

IV. DISCUSSION AND CONCLUSION

Synechocystis sp SC1 were isolated from gujar garhi Mardan. The isolated strain was cultured on modified version of BG11 medium. Strain were cultured for three weeks exposed to sun light and tube light and UV light. Growth of cyanobacterial strain were measured after 1, 2 and 3 weeks. Sunlight was the most suitable source of light for *Synechocystis sp SC1* to grow optimally. In previous study, light emitting diodes (LEDs) with peak emittance of 680 nm was found to be the excellent source of light for enhanced productivity of microalgae by up to 2-fold without changing the cell volume (Carvalho et al., 2011). Light is the most important factor which control growth of cyanobacteria. Light quality have a dramatic effect on biomass production of cyanobacteria. Previously two cyanobacterial strains were studied to determine the effects of various wavelength distributions and irradiance levels on growth kinetics Red light produced the highest growth rate as compared to white light (Barnettet al., 2015). Response of cyanobacteria to the UV light was mixed. *Synechocystis sp SC1* UV light was beneficial during initial exposure for 1, 3, 6 and 24 hours. To increase cell volume exposure of culture to white light was found suitable. Studies showed that growth of cyanobacteria is significantly affected by UV radiation. High UV-B radiations tend to decrease the chlorophyll contents of most of cyanobacteria. Also, exposure to UV-B has been shown to induce the production of absorbing compounds. Higher UV-B can also decrease the rate of photosynthesis. Decrease in chlorophyll contents and photosynthesis is subsequently followed by biomass production. However, algae and cyanobacteria have evolved various avoidance and repair mechanisms to protect themselves against the damaging effects of UV radiation (Xue et al., 2005).

Main objective of the current work was to monitor the ability of our isolates to absorb UV light. For this purpose, cultures exposed to different light sources including sunlight, tube light and UV radiation were tested in two ways. The culture supernatant was scan for UV absorbance in order to find extracellular UV absorbing compounds. Also, acetone extract from cyanobacterial

biomass was assayed which contained intracellular UV absorbing compounds. It was noted that most of the extracellular compounds were efficient in absorbing UV-C part of the spectrum, irrespective of the light source used. Tube light was most suitable source for the production of UV absorbing compounds. UV irradiation induces increase in extracellular UV absorbing compounds. Previously, it has been shown that exposure of a cyanobacterium *Nostoc sp F2 commune*to UV-A and UV-B irradiation enhanced the release of carotenoids, UV-A/B absorbing MAA which was correlated with glycan synthesis and extracellular Scytonemin. However, upon prolong exposure to UV-B release of scytonemin stopped whereas amount MMA`s content remained high (Ehling*et al.*, 1999).

Most of the UV-A and UV-B absorbing compounds were retained intracellularly by the isolated cyanobacteria. It was noted that acetone extract of the biomass showed absorbance in all the three regions of UV radiation. Sunlight was more optimum source of light as compared to tube light for the production of UV absorbing compounds. I effects of incubation time were mixed on different strains. Two weeks exposure were best time for isolate to producing absorbing compounds

Exposure of cyanobacterial cultures effectively induced the production of UV absorbing compounds in the isolate. *Synechocystis sp SC1* were the most responsive to UV light as their UV absorbing efficacy was maximum under such circumstances. Growth of cyanobacteria was highly affected by UV light. In case of *Synechocystis sp SC1* UV light was beneficial during exposure for 1, 3, 6 and 24 hours. Previously it was reported that UV exposure for different duration of time (10, 15, 30, 45 and 60 min) had negative influence on the growth of microalgae i.e. *Chlorella valgaris* (Ganapathy et al., 2017).

In case of *Synechocystis sp SC1*, maximum absorbance was at 258 nm which migt indicate the presence of a quercitin compound with maximum absorbance at 254 nm (Campbell et al, 1998). Similarly, absorbance at the wavelength of 268 nm, 280 nm, 234 nm and 238 nm might be due to the presence of MAA,s because this compound give single absorption band in the UV spectrum between 230 and 400 nm (Shourin et al, 2014). Absorption of the wavelengths 308 nm, 336 nm and 350 nm indicated the production of scytonemin which reportedly absorbs the wavelength of 252 nm to 350 nm (Sinha et al., 1999). .

Cultures of isolated cyanobacteria grown for three weeks followed by exposure to UV were assayed for the presence of flavonoids. There was a gradual time dependent increase in the amount of flavonoids released into culture. Amount of total flavonoids in the culture of *Synechocystis sp SC1* was higher In UV exposed cultures, production of flavonoids in *Synechocystis sp SC1* was increased for 12 hours. Upon exposure to UV radiations, flavonoids production was significantly increased in *Kalanchoepinnata*. Influence of UV radiations on the production of flavonoids has been studied in plants but not in cyanobacteria. Flavonoids constitute an important component of anti-oxidant system in living organism which is active in soothing the damaging effects of a number of environmental stresses including UV radiations (Nascimento et al., 2015). In addition, flavonoids may also be important in absorbing the UV radiations and hence safeguarding the delicate cell components from the damaging effect of harmful UV radiations (Ehling-Schulz et al., 1999).

Cultures of isolated cyanobacteria grown for three weeks followed by exposure to UV were assayed for the presence of phenols. There was a gradual time dependent increase in the amount of phenols released into culture. Amount of total phenols in the culture *Synechocystis sp SC1* was higher. In UV exposed cultures the production of phenols in *Synechocystis sp SC1* were increased for 24 hours.

V. Conclusion

It is concluded that sun light is a good source for *Synechocystis sp SC1*. Most of the cynobacterial isolates naturally produce and release UV-C absorbing compounds. However, exposure to UV light induces the production of UV-A and UV-B absorbing compounds. *Synechocystis sp SC1* produces more flavonoids in sun light and tube Production of phenols and flavonoids is greatly induced upon exposure of the isolated cyanobacteria to UV. Enhanced production of

phenols and flavonoids is beneficial for the protection of cyanobacteria against the damaging UV light.

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