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A NOVEL INDIGENOUS TUBULAR REACTOR FOR THE OUTDOOR CULTIVATION OF *SPIRULINA FUSIFORMIS*

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An attempt has been made to grow *Spirulina* cultures in the selfdesigned tubular reactor. Simultaneously comparative growth pattern in three different culture conditions was worked out. Growth was followed through optical density, Chl_a contents and biomass estimation. In closed cultivating system under outdoor conditions, better growth with maximum Chl_a content and biomass has been registered.

Keywords : Biomass; Chl_a content; Optical density; *Spirulina fusiformis*; Tubular reactor.

For the mass cultivation of commercial algae, mostly open ponds and tanks have been preferred. In the open system, water level management is a major problem, due to surface evaporation of water. Besides, open ponds and tanks fall prey to contamination, whereas there is no remedial technique to prevent the entry of the contamination in the algal open ponds. In the recent years closed reactors have also been explored for the commercial cultivation of *Spirulina*. Helicoidal photobioreactor was used for *Spirulina* and *Chlorella* cultivation[1]. *Spirulina* was also grown in a two plane tubular photobioreactor[2]. The study with *Chlorella pyrenoidosa* was performed with the cuboidal photobioreactor[3]. Several workers[4,5] carried out production of *Spirulina platensis* in a helical tubular photobioreactor. Others[6,7] have opted flat plate photobioreactor and curved tubular photobioreactor for the cultivation of *Spirulina*. The manufacturing of these closed reactor was cost effective. Therefore, an economically feasible and easily fabricative tubular reactor was self-designed for *Spirulina* cultivation.

Spirulina fusiformis was cultured in CFTRI medium. A simple closed tubular culture containers was made out of a transparent tubular polyetheylene, 9 cm in diameter and 90 cm in length. Three tubular reactor with one litre healthy growing *Spirulina* cultures were employed. Both the sides of the reactors were plugged with cotton to provide proper aeration. Reactors were laid on the thermocol sheets for providing white background to the culture for the desired penetration of light and insulation. Both the ends were clamped on either side.

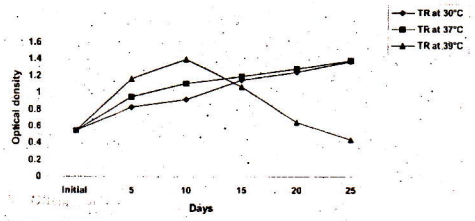
The growth of the cultures in the tubular reactors, under three different sets of culture conditions was compared (plate 1-A, B&C). The culture conditions varied in temperature and light intensity. 30°C temperature with 146 lux light intensity and 37°C temperature with 732 lux light intensity in the laboratory conditions receiving 12h/d light period, while in outdoor premises temperature was 39°C with the diffused light of 50 klux for approximately 12 ± 2h/d period.

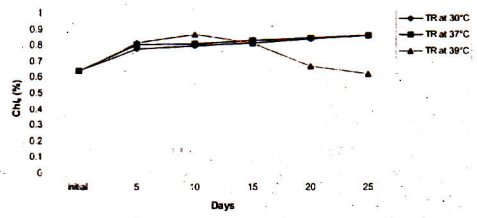
In addition of tubular reactors a conical flask of 2L capacity with 1L cultures was also placed in laboratory conditions of 30°C temperature and 146 lux light intensity (plate 1-D) and a plastic tub of 2 L capacity containing 1L algal cultures was placed in outdoor premises (plate 1-E). The growth was recorded initially and then 5 days apart, over a period of 25 days.

Initial density of algal cultures was adjusted to 0.55 (Fig. 1, 4 & 7). Chl_a content and algal biomass was 0.641% & 0.275 g/l, respectively (Fig. 2, 5, 8 & 3, 6, 9).

On 5th day, cultures in outdoor premises at 39°C showed higher growth levels, through all the three parameters which continued for yet another 5 day.

After 15 days, the performance of





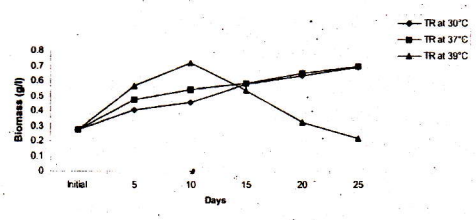
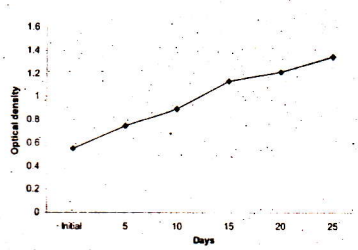
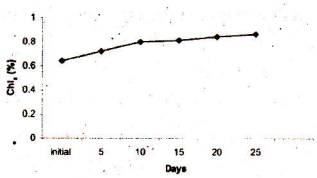


Fig. 1. Growth of *Spirulina fusiformis* grown in tubular reactors (TR)

Fig. 2. Chl_a contents of *Spirulina fusiformis* grown in tubular reactors (TR)

Fig. 3. Biomass of *Spirulina fusiformis* grown in tubular reactors (TR)





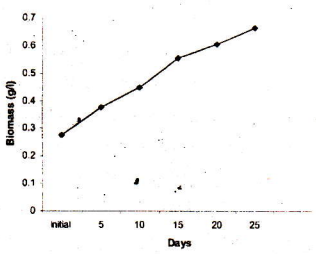


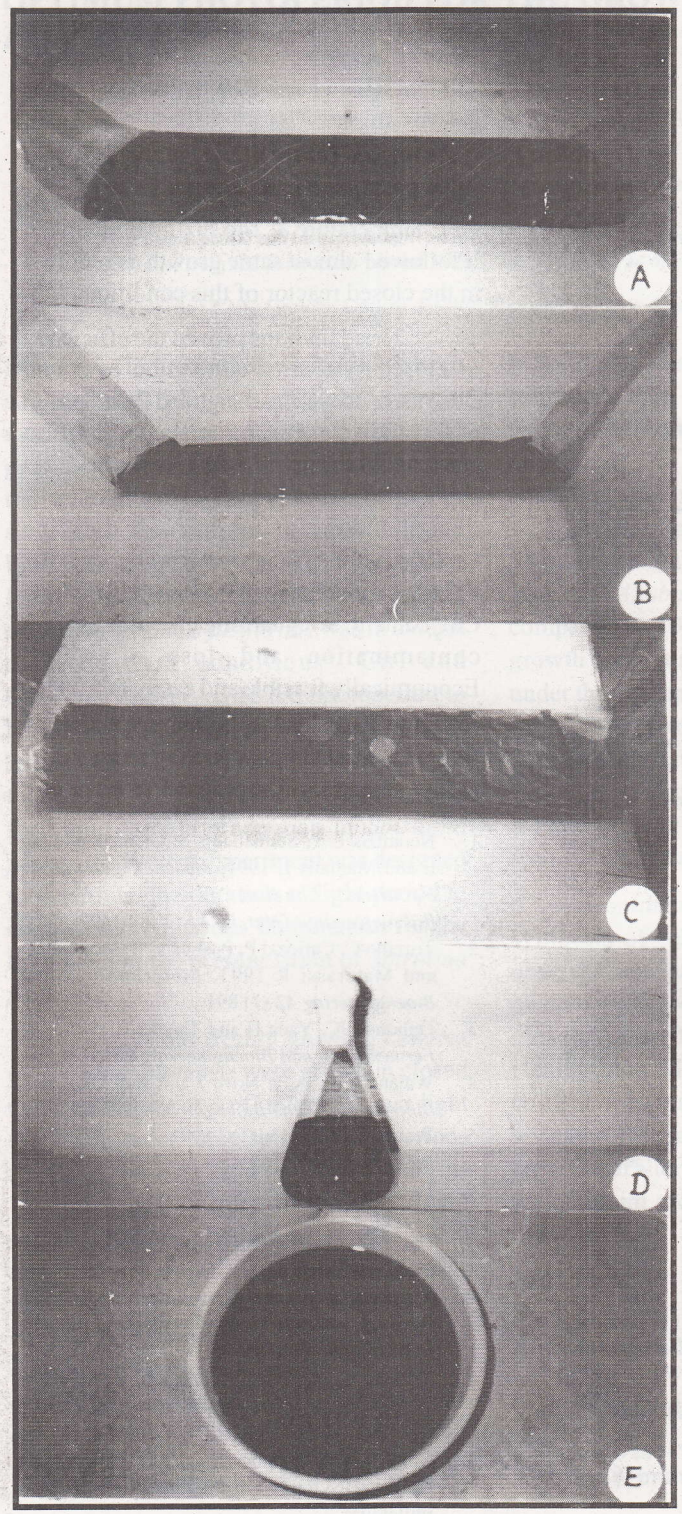
Fig. 5. Growth of *Spirulina fusiformis* grown in flask

Fig. 2. Chl_a contents of *Spirulina fusiformis* grown in flask

Fig. 6. Biomass of *Spirulina fusiformis* grown in flask

cultures varied to some extent. Cultures of outdoor grown tubular reactor (Fig. 1) and tub (Fig. 7) showed reduction in their growth, while other culture samples showed linear increase in all the parameters of the growth, which continued for the remaining experimental period.

The growth of the alga was highest in tubular reactor placed in outdoor conditions at 39°C with a light intensity of 50 klux. The saturation in growth was reached within 10 days, thereafter it declined. It was followed by the reactors at 37°C and 30°C with light intensity of 732 and 146 lux, respectively. The growth of *Spirulina* in these two reactors was linear but required 25 days to be on par with the reactor placed in open premises with diffused light of 50 klux. Hu *et al.*[6] also found highest algal concentration and biomass productivity for *Spirulina platensis* at the highest light intensity. Vatsala *et al.*[8] obtained maximum biomass yield of *Botryococcus braunii* in photoreactor in outside conditions rather than in the photoreactor placed inside the laboratory. Besides, Torzillo *et al.*[9] observed reduction in productivity, under low temperature conditions. All these reports are consonant with the present findings. The growth through Chl_a content and biomass of the algae followed the same sequence as that of optical density.



Tubular Reactor at 30°C temperature with 146 lux light intensity for 12 h/d light period

Tubular Reactor at 37°C temperature with 732 lux light intensity for 12 h/d light period

Tubular Reactor at 39°C temperature with diffused light of 50 klux for 12 ± 2 h/d light period

Conical flask at 30°C temperature with 146 lux light intensity for 12 h/d light period

Plastic tub at 39°C temperature with diffused light of 50 klux for 12 ± 2 h/d light period

Plate. Cultures of *Spirulina fusiformis* in different conditions.

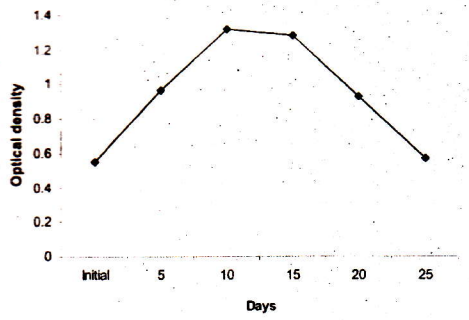


Fig. 7: Growth of *Spirulina fusiformis* grown in tub

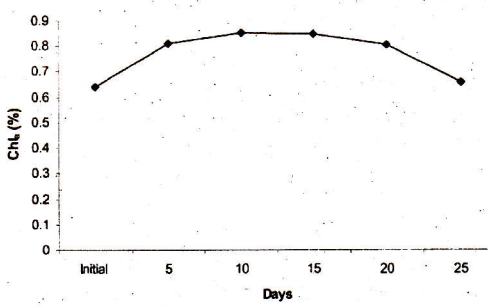


Fig. 8: Chl$_a$ contents of *Spirulina fusiformis* grown in tub

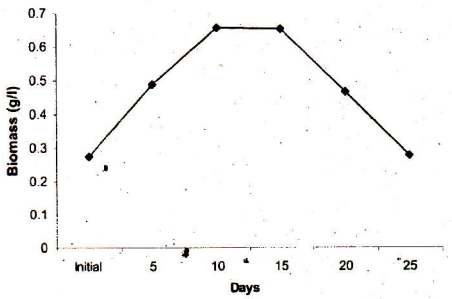


Fig. 7. Growth of *Spirulina fusiformis* grown in tub

Fig. 9. Chl$_a$ contents of *Spirulina fusiformis* grown in tub

Fig. 9. Biomass of *Spirulina fusiformis* grown in tub

When the equal amount of *Spirulina, cultures* were placed in a tub, the tub grown cultures showed less growth than the reactor grown sample.

Similarly, when a flask cultures taken into consideration under the conditions of 30°C temperature & 146 lux light intensity. It followed almost same growth as reported in the closed reactor of this condition.

These findings proved the efficiency of closed system of cultivation over and alone the open systems. Singh and Richmona's[10] observation on *Porphyridium* sp. confirm present findings. The pilot experiment proved that simple and convenient self-designed tubular reactor can best be employed for efficient utilization of solar irradiance yielding better biomass with high Chl$_a$ content, safeguarding the cultures from contamination and loss of water. Economically feasible and easily fabricated transparent tubular reactor may be suggested for large scale cultivation of *Spirulina*.

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