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Experimental assessment of productivity, oil-yield and oil-profile of eight different common freshwater-blooming green algae of Kerala

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ABSTRACT

Better strains of green algae of desirable biomass yield and oil characteristics are important to algal-based bio-industries. Biomass-yield per unit time, oil productivity per unit biomass, chemical characteristics of oil, nutritional significance and biofuel potentials of the oil of eight different common freshwater-blooming green-algae are compared. Preliminary screening for lipid richness was carried out using Sudan-black lipid staining method. Selected algae were cultured in Bold's Basal Medium under uniform laboratory condition for 30 days. Fatty acid profiling was done by GCMS and the preliminary biodiesel feasibility was confirmed by FTIR. Percentage composition of omega-3, omega-6 and omega-7 group of fatty acids was used to assess the nutritional value of the oil. Algal biomass yield of the eight species varied from 35.4% to 201.6% mg/L/Day. The biomass-yield and oil productivity of *Keratococcus bicaudatus* is reported for the first time, which is quite comparable to *Botryococcus spp.,* one of the universally well known species in this regard. Another species *Monoraphidium obtusum* is observed to contain good quantity of omega-3 fatty acids (13.18%). The oil of the different species of algae showed 6.06–82.14% saturated fatty acids, 1.14–25.92% monounsaturated fatty acids and 0.79–41.26% polyunsaturated fatty acids. Since C14 to C18 fatty acids are considered as the feed-stock for quality based biodiesel, presence of such fatty acids in the oil of all these algae is a preliminary indication for biodiesel feasibility of the same, further confirmed by FTIR of its methyl esters.

1. Introduction

Algae in general are the fastest growing photosynthetic organisms, which account for about 50% of the organic carbon photo-synthesized on the earth (Field et al., 2009). The multitude of biological characteristics, morphological variability and adaptability to grow in almost all kinds of aquatic and terrestrial wet environments impel algae as an extremely attractive organism for commercial utilization (Hallman, 2007). Along with the potential of algae as agents of fast sequestration of carbon (Basu et al., 2013) and industrially significant biomass, they are also highly useful in the recovery of lost nutrients as well as reclamation of polluted water (Chiu et al., 2015). In addition to the earlier industrial uses of individual algae as food, feed, food-additives, cosmetics, and pigments (Pulz and Gross, 2004), research on algae is now more focused on combining carbon sequestration, fuel efficiency, phycoremediation potentials and other commercially valuable qualities in single species. Naturally, the progress and sustenance of algal industries depends on the identification of better strains for combination of as many desirable qualities as possible as well as intensive research on problems and prospects of their biotechnological applications.

Among the diverse categories of micro algae, green algae are unique with plenty of species growing in both marine and freshwaters. Moreover, green algae are currently used in the industrial sector, especially for the production of nutritionally valuable food and oils. Oil from many algae is edible; some algal oils have medicinal characteristics and are easily convertible to biodiesel (Spolaore et al., 2006; Stengel et al., 2011; Skjånes et al., 2012; Vanthoor-Koopmans et al., 2013; Ullah et al., 2014, 2015). Algal oil is looked forward to be better option to fossil fuels (Campbell, 2008). Oil of green algae has wide applications in pharmacy, health and cosmetic industries (Priyadarshani and Rath, 2012).

The valuable organic compounds of green algae are found either as reserve food or as other cellular inclusions. Among the various storage compounds present in the green algae, lipids are found in significant quantities in certain species, which make them very valuable as 'green gold' for future biofuel economy. Green algal biomass rich in oils are currently considered as precious resource for biofuel and nutraceutical industries (Barry et al., 2015; Adarme-Vega et al., 2012). Photosynthetic efficiencies and oil productivity of green algae are

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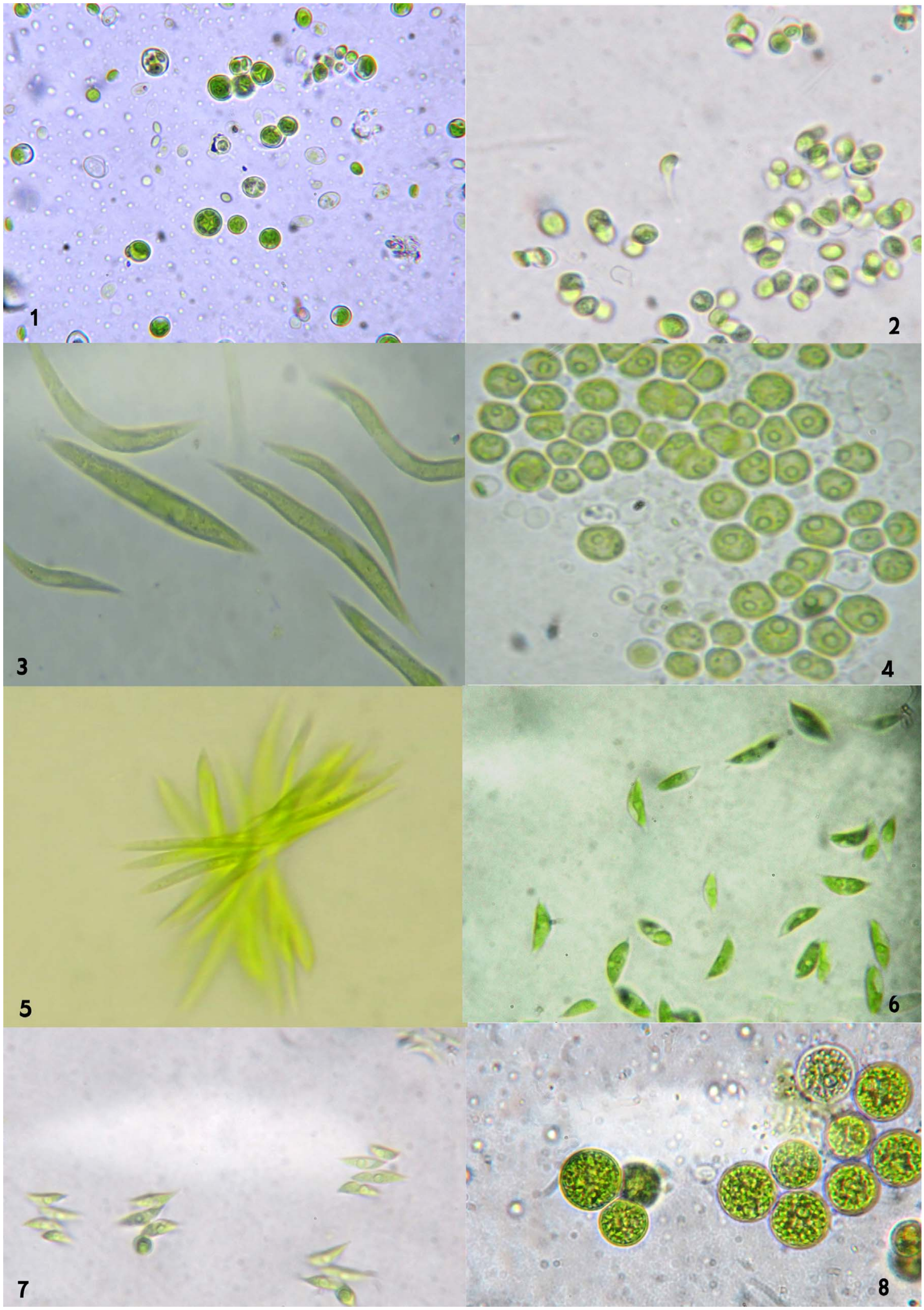

Fig. 1. Lipid-rich green algal species isolated from the bloomed freshwater bodies of Kerala; *1. Bracteacoccus minor, 2. Dictyosphaerium pulchellum, 3. Monoraphidium obtusum, 4. Scenedesmus rubescens, 5. Ankistrodesmus falcatus, 6. Keratococcus bicaudatus, 7. Scenedesmus dimorphus, 8. Chlorococcum infusionum.*

higher than that of other biomass and oil generating species (Hu et al., 2008; Brownbridge et al., 2014). Unlike other oil crops, algae do not compete for land resources. Green algae can be cultivated even in polluted waters, and the same water may be repeatedly used for further cultivation. Naturally, dependence on green algal biomass for food and fuel seems significant to global sustainable development (Chisti, 2010).

Physical and chemical quality of the oil of algae for biodiesel or medicinal or other valuable uses depends on the structural features of