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Effects of light intensity and carbon dioxide on lipids and fatty acids produced by Synechocystis sp. PCC6803 during continuous flow

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We studied the effects of light intensity (LI) and CO_2 supply on pH and total lipid production and fatty acids by Synechocystis sp. PCC6803 during continuous-flow operation of a photobioreactor having continuous nutrient supply. The temperature was fixed at 30 °C, and the LI pattern mimicked a day/night light cycle from 0 to 1920 μmol/m^2 s. The CO_2 supply varied from1 to 5% v/v of total air. The total lipid content increased proportionally to LI, reaching a high content of 14% of dry weight (DW) at the highest LI at 3% CO_2. In contrast, LI had no significant influence on the total fatty acid content, which was 3.4% ± 0.5% DW, measured as fatty acid methyl esters (FAMEs). Palmitic acid (C16:0) was the main fatty acid (52% of FAMEs), but γ-linolenic acid (C18:3^{n6}) and linoleic acid (C18:2) were significant at 20% and 14% of total FAMEs, respectively. Also, a-linolenic acid (C18:3n3), oleic acid (C18:1), and palmitoleic acid (C16:1) represented 5%, 4%, and 4% of the total FAMEs, respectively. In case of C16:0, its highest content was achieved at LI of 400 to 1500 μmol/m^2 s and pH media values from 7.2 to 8.8 (3% CO_2). The highest formation of C16:1 and C18:1 (desirable for biodiesel production) occurred with LI up to 600 μmol/m^2 s at pH 9 (3% CO_2). Stearic acid (C18:0) and linoleic acid (C18:2) contents did not vary with LI or pH, but α-linolenic acid (C18:3^{n3}) formation occurred with patterns opposite to C18:3^{n6}, C16:0, and C16:1. LI of 400 to 1600 μmol/m^2 s and pH range from 7.7 to 8.7 led to the highest values of C18:3^{n6} (0.8% DW), but C18:3^{n3} was suppressed by these conditions, supporting a desaturation pathway in Synechocystis. These results point to strategies to optimize LI, CO_2, and pH, to enhance the fatty acid production profile for biofuel production.

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