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Enhancement of dye sensitized solar cells by introduction of L-Ascorbic acid to the natural dye extraction of *Carissa carandas* fruit

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Dye sensitized solar cells are categorized under third generation solar cells where a standard cell consists of nanocrystalline semiconductor photo anode which is very often titanium dioxide (TiO_2), a dye sensitizer, a redox electrolyte and a counter electrode. Replacement of inorganic dye with natural organic dye as the sensitizer in these cells has gained both academic and commercial interest because it provides low cost, easy fabrication and non-toxic alternatives to inorganic dyes of dye sensitized solar cells. In this investigation, the dye extracted from *Carissa carandas* (Jamson) fruit was used as the dye sensitizer modified using L-ascorbic acid. The optical characteristics of dye and L-ascorbic acid were investigated separately by UV-visible spectroscopy. The maximum absorption wavelength of ascorbic acid was at 239 nm which is in the UV region and it was at 541nm in the visible region for the dye extraction. The TiO_2 working electrodes were prepared by doctor blade method. Sintered TiO_2 films were coated with extracted dye and L-ascorbic acid to explore the attachment of ascorbic acid molecules with dye molecules on the TiO_2 photoanodes using three methods. The three methods of treatment of photo anodes with ascorbic acid were as follows; (1) TiO_2 films were soaked in dye solution mixed with the ascorbic acid, (2) dye coated TiO_2 films were soaked in L-ascorbic acid solution and (3) ascorbic acid coated TiO_2 film were soaked in dye solution. The soaking time of TiO_2 films in each solution was restricted to one hour. By varying the concentration of L-ascorbic acid in the solutions, series of cells were prepared to investigate the optimum concentration of ascorbic acid which gives the highest efficiency in each method. Platinum electrode was used as the counter electrode to assemble the dye sensitized solar cell and the space between photo anode and counter electrode was filled with a liquid electrolyte containing I^-/I_3^- redox couple. Photovoltaic characterizations were done under 100mWcm^{-2} of light source. The highest efficiencies of dye sensitized solar cells for each three methods were 1.498%, 1.151% and 0.3078% at the optimum concentrations of ascorbic acid 0.14 M, 0.28M and 0.14M respectively. The observations support the idea of suppression of dye quenching by the ascorbic acid attached in between dye molecules to enhance the efficiency of the dye sensitized solar cells.

Keywords: *Carissa carandas* (Jamson), Dye sensitized solar cells, Photovoltaic characteristics