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## New dual-stage pH control fed-batch cultivation strategy for the improvement of lipids and carotenoids production by the red yeast *Rhodospiridium toruloides* NCYC 921



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### HIGHLIGHTS

- Medium pH for the lipid and carotenoid production by *R. toruloides* is different.
- A dual step pH control fed-batch strategy improved the yeast products production.
- The oxygen played a crucial role in the yeast carotenoid synthesis.

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### ABSTRACT

The optimal medium pH to produce biomass and fatty acids by the red yeast *Rhodospiridium toruloides* NCYC 921 is 4.0, and to produce carotenoids is 5.0. Based on this difference, a dual-stage pH control fed-batch cultivation strategy for the enhancement of lipids and carotenoids production by this yeast was studied. The results showed that when the yeast growth phase was conducted at pH 4.0, and the products accumulation phase was conducted at pH 5.0, biomass, total fatty acid and total carotenoid productivities were significantly improved comparing with the yeast fed batch cultivations carried out at fixed medium pH (4 or 5). Under dual-stage pH control conditions, the biomass, carotenoids and lipids productivities attained 2.35 g/L h, 0.29 g/L h and 0.40 g/L h, respectively. It was also observed that the oxygen played a major role in the yeast carotenoid production.

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### 1. Introduction

The use of fossil fuels raises serious environmental concerns such as greenhouse gas (GHG) emission. Carbon dioxide is one of the GHG that contributes to global warming, causing the average surface temperature of the Earth to rise in response, which will cause major adverse effects to mankind. A global movement towards the generation of renewable energy is therefore under way to help reduce global greenhouse gas emissions.

Biodiesel is considered an ecological fuel as it is biodegradable, non-toxic and emits less gaseous pollutants than normal diesel (Kumar and Pal, 2014). However, biodiesel derived from the current sources (oil crops, waste cooking oil and animal fat) can only satisfy a small fraction of the existing demand for transport fuels (Chisti, 2007). Oleaginous microbes such as microalgae and yeasts can be used as biodiesel feedstocks. Indeed, these microorganisms

grow faster than crop cultures and their cultivation is non seasonal. Among oleaginous microorganisms, yeasts have a few advantages over bacteria, molds and algae, due to their higher growth rate, biomass and lipid productivities (Braunwald et al., 2013). Moreover, biodiesel production from yeasts is of particular interest for countries located at higher latitudes, where the daylight is not as long as in countries closer to the tropics, wherein autotrophic microalgae may be more suitable (Freitas et al., 2014a).

However, at the moment, biodiesel derived from microbes is still economically unsustainable, as its production costs are higher than first generation biodiesel (Schneider et al., 2013). Therefore, new strategies must be attained, in order to reduce the overall costs. If the microbial biomass, beyond its high lipid content, is rich in high value added products such as carotenoids (which have many applications in pharmaceutical, nutraceutical, food and feed industries, with a high market value) their commercialization may contribute to reduce the overall process cost (Lopes da Silva et al., 2014).

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