Bioprocess Biosyst Eng (2018) 41:143–155
DOI 10.1007/s00449-017-1853-4

RESEARCH PAPER

Influence of culture conditions towards optimal carotenoid production by *Gordonia alkanivorans* strain 1B

Ana S. Fernandes[1] · Susana M. Paixão[1] · Tiago P. Silva[1] · José C. Roseiro[1] · Luís Alves[1]

Received: 23 June 2017 / Accepted: 10 October 2017 / Published online: 17 October 2017

Abstract With the increasing awareness on the toxicity of several synthetic dyes, demand for pigments from natural sources, such as microbial carotenoids, has gained interest as a promising safe alternative colour additive. In this study, a surface response methodology based on the Doehlert distribution for two factors [% of glucose in a mixture of glucose + fructose (10 g/L total sugars), and sulfate concentration] was used towards the optimal carotenoids production by *Gordonia alkanivorans* strain 1B in the presence of light (400 lx). Time influence on pigment production by this bacterium was also evaluated, as well as the cell viability profile during longer incubation periods at optimal conditions. Indeed, the highest carotenoid production (2596–3100 μg/g_{DCW}) was obtained when strain 1B was cultivated in the optimal conditions: glucose 10 g/L and sulfate ≥ 22 mg/L, in the presence of light for 19 days at 30 °C, 150 rpm. Flow cytometry showed that the highest production was somehow related with the cellular stress. These results highlight the great potential of strain 1B as a new hyperpigment producer to be exploited towards several applications.

Keywords *Gordonia alkanivorans* strain 1B · Surface response methodology · Doehlert distribution · Carotenoid production · Flow cytometry

✉ Susana M. Paixão
susana.alves@lneg.pt

✉ Luís Alves
luis.alves@lneg.pt

1 LNEG–Instituto Nacional de Energia e Geologia, IP, Unidade de Bioenergia, Estrada do Paço do Lumiar, 22, 1649-038 Lisboa, Portugal

Introduction

Carotenoids are mostly known as nutritionally beneficial organic pigments naturally occurring in the plastids of photosynthetic organisms (plants, algae, and phototrophic microorganisms). However, these molecules can also be found in some non-photosynthetic organisms, such as bacteria, moulds, and yeasts, where their main function is to protect the cell from the damage caused by oxygen and light. Carotenoids are liposoluble pigments responsible for the colours of plants, algae, some animals, and microorganisms, ranging from yellow to orange, pink, or red according to their chemical structure [1–4].

Typically, carotenoids are C_{40} tetraterpenoids formed by eight C_5 isoprenoid units joined head to tail and have a tail-to-tail linkage in the centre, resulting in a symmetrical structure. These molecules have a central chain that alternates sequentially between double and single bonds, and can have a ring at one or both ends of the molecule, or be acyclic. They are obtained from the isoprenoid pathway [2, 5]. Carotenoids can be divided into two main classes: (a) carotenes, which are purely hydrocarbons (β-carotene, torulene, α-carotene, and lycopene) and (b) xantophylls, which are similar, but present functional groups containing oxygen: hydroxyl groups (e.g., lutein and zeaxanthin), keto/oxo groups (e.g., echinenone, astaxanthin, and canthaxanthin), epoxide groups (e.g., violaxanthin, antheraxanthin, and neoxanthin), or methoxy groups (e.g., spirilloxanthin) [2, 4, 6, 7].

Other than their colour and light harvesting properties, carotenoids have diverse bioactive and chemical properties. These compounds can present antioxidant activities, with specific roles or general health-promoting roles that reduce the risk or progression of diseases associated with oxidative stress. They can be precursors to vitamins, have