Biocatalysis and Agricultural Biotechnology 9 (2017) 183–194

Contents lists available at ScienceDirect

Biocatalysis and Agricultural Biotechnology

journal homepage: www.elsevier.com/locate/bab

Derivates of azaphilone Monascus pigments

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ARTICLE INFO

Keywords:
Monascus pigments
New azaphilone
Physicochemical properties

ABSTRACT

Progress Research on *Monascus* pigments has been very rapidly, includes the discovery of new pigments and methods used for the isolation and identification of new pigments. Currently, nearly fifty seven new pigments have been found which are derivatives of the six main pigments that already exist. The process of discovery of new pigments can not be separated from the process which are carried out during fermentation or during the isolation. This review includes data from all fifty new pigments following chemical structure data, chemical formula, the level of water solubility, the value of Log P, *Monascus* strain, substrates used in the fermentation process and methode to identification. Data collected from various studies that have been done before, and added with some of the new data. The aim of this review is to give more comprehensive data about *Monascus* pigments.

1. Introduction

Monascus pigments (MPs) has long been used as a natural food colorants (natural food colorant), especially in some Asian countries such as South China. *Monascus* produce red yeast rice, which is rice fermented by a red *Monascus* sp. Angkak can be used to dye yoghurt, bacon, sausage, and for the preservative of fruits, vegetables, and fish products (Singgih and Julianti, 2015).

Monascus pigments (MPs) have many applications such as coloring agents in foodstuffs and texture industries, pharmacology, medicine and cosmetics (Mostafa and Abbady, 2014). Moreover, MPs have a range of biological activities, such as antimutagenic and anticancer properties (Hsu et al., 2011), antidiabetic effects (Shi and Pan, 2011; Lee et al., 2011) antimicrobial activities (Martlnková et al. 1995; Kim et al., 2006; Vedruscolo et al., 2014), potential anti obesity characteristics (Feng et al., 2012), and capable to producing antioxidants and dimerumic acid (Tseng et al., 2006; Yang et al., 2006; Pyo and Lee, 2007).

Monascus pigments are a group of fungal metabolites called azaphilones. The main pigments produced by *Monascus* sp, especially *M. pilosus, M. ruber and M. purpureus*, are six well-known compounds: two yellow pigment monascin and ankaflavin (Chen et al., 1969; Manchand and Whalley, 1973), two orange pigments rubropunctatin and monascorubrin (Chen et al., 1969), and two red pigments monascorubramine and rubropunctamine (Kumasaki et al., 1962; Sweeny et al., 1981).

In the past of decades, more than 57 azaphilone pigments from *Monascus* species have been identified and characterized including categories and structures, physicochemical properties, detection method, functions and molecular biology. (Feng et al., 2012) and biological activity (Patakova, 2013; Mostafa and Abbady, 2014).

2. *Monascus* Pigment Production

2.1. Strain

More than twenty *Monascus* species are presented in the literature, however only certain species and strains of the fungus Monascus are used to produce MPs which include mainly *M. argentinensis* (Kim, 2010), *M. anka* (Shi et al., 2015), *M. bakeri, M. floridanus* (Vasilyeva et al., 2012), *M. kaoliang* (Lin and Lizuka, 1982; Cheng et al., 2015), *M. lunispora, M. mayor, M. pilosus* (Cheng et al., 2013; Wu et al., 2015), *M. pubrigerus, M. purpureus* (Rezael et al., 2011), *M. ruber* (Mostafa and Abbady, 2014), *M. fallen, and M. auriantacus* (Srianta, 2015), *M. sanguines* (Dikshit and Tallapragada, 2012). Many mutants strains are also used in fermentation to produce *Monascus* pigments. In China, *M. anka* strains such as mutant MYM are used to produce MPs (Zhou et al., 2016). Other *Monascus* strains were isolated and applied for MPs production, for example, mutant R-10847 derived from *M. kaoliang* F-2 (ATCC 26264) (Lin and Lizuka 1982), and *M.*

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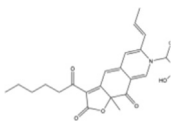
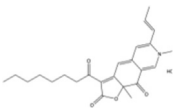
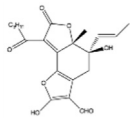
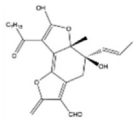
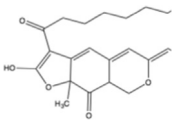
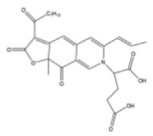
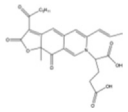
http://dx.doi.org/10.1016/j.bcab.2016.12.014
Received 17 December 2016; Accepted 21 December 2016
Available online 28 December 2016
1878-8181/

Table 1
The properties data of derivates azaphilone Monascus pigments.

No	Chemical Structure	Chemical	Molecular Weight	Solubility Water (mg/L)	Octanol (mg/L)	Log P	Name of Pigment	Production strain and substrate	Colour	Identification Methode	Reference
1		$C_{30}H_{39}NO_9$	557.64	0.2901	1.36	0.67	N-glucosyl rubropuctamine	Derived from rubropuctamine	Red	UV	Moll and Farr (1976)
2		$C_{32}H_{43}NO_9$	585.69	0.2759	9.03	1.51	N-glucosyl monascurobramine				Feng et al. (2012)
3		$C_{21}H_{24}O_7$	388.15	383.3	241.84	−0.2	Xantomonascin A	*Monascus pilosus* grownon rice	Yellow	HPLC, MEKC-ESI-MS	Sato et al. (1992)
4		$C_{24}H_{30}O_6$	414.20	18.8	55.48	0.47	Xantomonascin B				
5		$C_{22}H_{28}O_5$	372.19	6.886	267.89	1.59	Yellow II	*Monascus* spp from commercial fermented soybean curd on cassava medium	Yellow	IR, MS, NMR	Yongsmith et al. (1993)
6		$C_{28}H_{33}NO_8$	511.22	0.4876	12.247	1.4	N-glutaryl monascorubramine	*Monascus sp* TTWWB 6093 on fermentation medium	Red	UV, MS, IR, NMR	Lin et al. (1992) Blanc et al. (1994)
7		$C_{26}H_{29}NO_8$	483.19	5.089	18.477	0.56	N-glutaryl rubropuctamine				
8		$C_{20}H_{22}O_6$	358.14	2754	39807.4	1.16	Monankarin A-B	*Monascus anka* culture medium	Yellow needles	HPLC, NMR, HR-ES-MS. IR	Hossain et al. (1996)

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