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Colorants and cancer: A review

Amrita Anantharaman, Babu Subramanian, Rajasekaran Chandrasekaran, R. Seenivasan, Ramamoorthy Siva*

School of Bio Sciences and Technology, VIT University, Vellore 632 014, Tamil Nadu, India

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ABSTRACT

Plants have a wide array of colors in different parts of their body and have been used for multiple purposes. Several colored components (secondary metabolites) such as anthocyanins, carotenoids, apocarotenoids, anthraquinones, flavonoids, etc., were investigated for their potential therapeutic efficacy as antitumorigenic agents. These colored molecules have the ability to interfere and involved in multiple cell signaling pathway such as cell death, cell survival and cell cycle pathway. In this article, we review the different colorants and their role in killing cancer cells. *In vitro* molecular mechanism of colored components differs against multiple cancer cell line that provides a guide to produce a further step in *in vivo* cancer treatment studies. It has been observed that there are numerous colorants can be used against cancer cells. Though there is a large resource of plant colorants with antioxidant properties, very little has been exploited so far. The detailed study on colorants will improve our knowledge in cancer biology and also facilitate the use for cancer treatment in near future.

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Contents

1. Introduction

Natural products as well as their derivatives are the essential component of the pharmaceutical industry for drug development over the years had relied on small molecules (Umeno et al., 2005). Plants being endowed with a plethora of secondary metabolite remains the first choice for scientists worldwide as the harbinger of therapeutically potent natural bioactive compounds. A diversity of secondary metabolites obtained from natural origin showed moderate to good therapeutic efficacy. The utilization of natural dyes for varied coloring applications has been a practice dating back to pre-historic time (Siva, 2007; Siva et al., 2009). Interest in natural dyes have considerably increased during the past few years because of the environmental safety concerns and also to eradicate the use of certain harmful synthetic dyes (Badami et al., 2004; Siva et al., 2008). The free radical scavenging properties of several colored components (secondary metabolites) have been investigated for their potent therapeutic efficacy (Singh et al., 2005; Siva

* Corresponding author. Tel.: +91 416 2202542/+91 944 3448905; Fax: +91 416 2243092.
E-mail address: rsiva77in@rediffmail.com (R. Siva).

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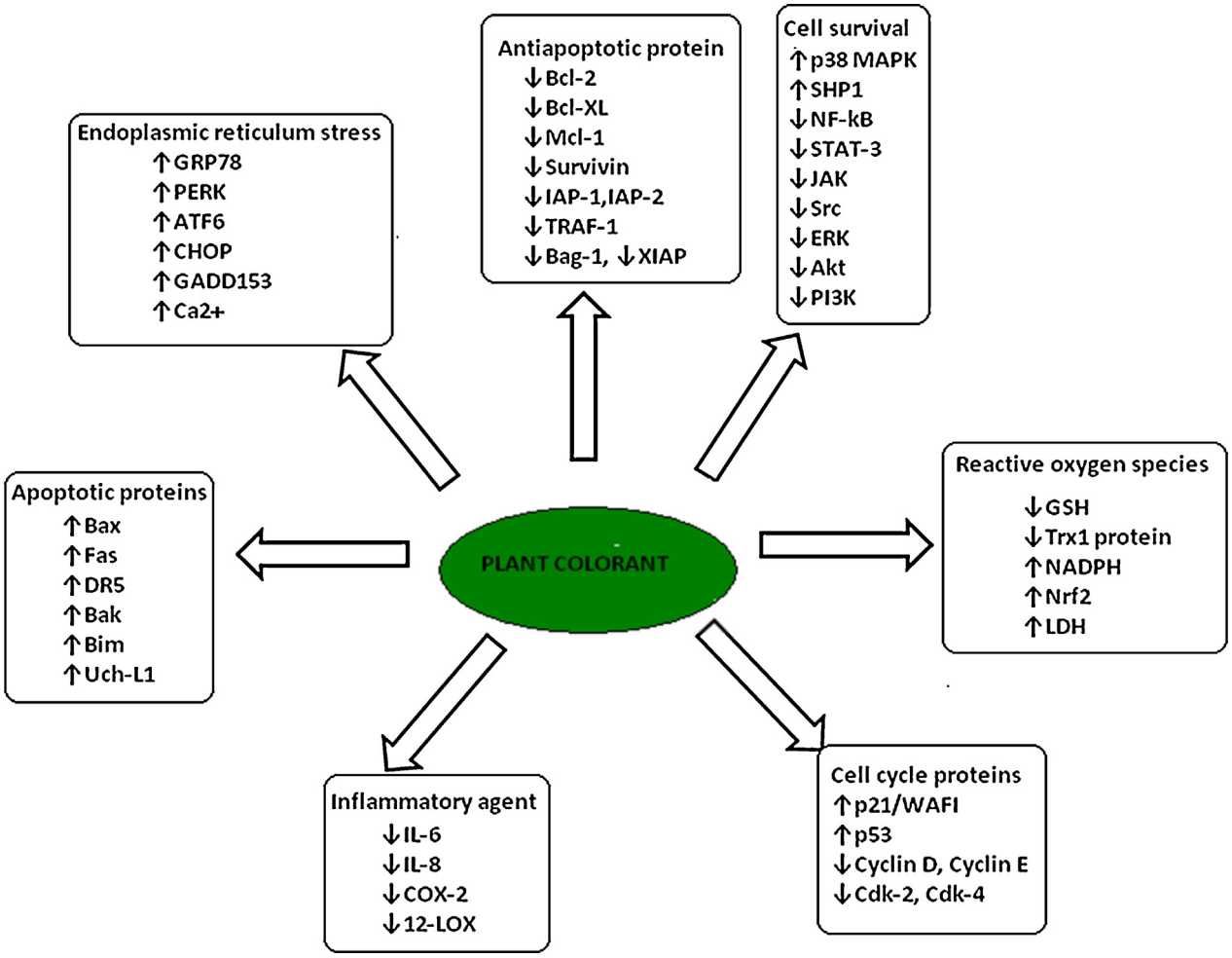

Fig. 1. Schematic representation of *in vitro* molecular targets of plant derived colorants towards multiple cancer cells.

et al., 2011; Bhakta and Siva, 2012a; Bhakta and Siva, 2012b). For example, *Punica granatum* and many other common natural dyes are reported as potent antimicrobial agents owing to the presence of a large amount of tannins. Studies indicated that, turmeric the smartest of the naturally-occurring yellow dye is a powerful antiseptic which revitalizes the skin and mitigates renal inflammation (Epstein et al., 2010). Likewise, many of the anthraquinones have been proven to be loaded with antioxidant, anti-inflammatory, purgative and astringent activities (Jasril et al., 2003; Ishak et al., 2010; Bhakta et al., 2013). Consequently, prospecting the role of certain plant dyes in human healthcare indubitably is a fruitful venture. In the present review, we highlight recent studies on the plant colorant in cancer preventive activities, especially from *in vitro* cancer cell culture studies (Fig. 1).

1.1. Cancer

The cancer disease is an uncontrolled cell growth and spread of abnormal cells *i.e.* unable to form stable structural function (Floor et al., 2012). It can be induced through external factors (tobacco, molecular pathogens, and UV radiation) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism) which can act together or in sequence (American Cancer Society, 2013). The total numbers of cells in the human body are balanced by cell growth and apoptosis mechanism. Nearly 100–130 billion cells have been killed through programmed cell death every day. The development of cancer, a hyperproliferative disorder occurs when this balance has disrupted (Ravindran et al., 2009).

The occurrence of four common types of humans cancer are carcinoma (90%), sarcoma (2%), leukemia (8%) and lymphoma (8%) (Ravindran et al., 2009). Dikshit et al. (2012) reported that based on the age and sex, an epidemiological cancer survey in India during 2010 showed 71% of death due to cancer occurrence among 30–69 years age. Moreover it has been observed that three most fatal cancers for men were oral (22.9%), stomach (12.6%), lung (11.4%) and for women cervical (17.1%), stomach (14.1%), breast (10.2%). Apart from this, the cancer death caused by tobacco consumption was 42% in males and 18.3% in females which were twice the death from oral and lung cancer. Khanna et al. (2005) stated that 10 million people are diagnosed with cancer in which 6 million people die every year.

Most of the cancer's formation evolved through the malfunction of genes that control cell growth and division. For example: 30% of human breast cancer have upregulated oncogene HER/neu expression (Chang et al., 2012) and mutations in the tumor suppressor p53 gene causes more than 50% cancer formation (Bai and Zhu, 2006). The tumor outgrowth and metastasis were a gravitational force for cancer invasion that takes place in a stepwise manner by migrating into cellular and extracellular matrix barrier to invade other tissue (Chen et al., 2011). The cancer cells differ from normal cells in which former prevent growth inhibitors and apoptosis, increase tissue neovascularization and cell proliferation. Most of the chemotherapeutic agents used in cancer treatment are highly expensive and produce side effects (Ravindran et al., 2009).

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