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Comprehensive review on flavonoids biological activities of *Erythrina* plant species

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ABSTRACT

Erythrina species (Fabaceae) or coral trees are widely distributed in tropical and subtropical regions worldwide. They are used in traditional medicine for the treatment of various ailments, such as anxiety, inflammation, wound healing, and microbial infections. Alkaloids and flavonoids are the main bioactive constituents isolated from genus *Erythrina*. The present review sheds light on *Erythrina* species flavonoidal content, that can serve as lead compounds in managing various diseases, including oxidative stress, inflammation, diabetes, and cancer. It is a comprehensive study of the flavonoidal constituents from *Erythrina* species, with their structural diversity and reported biological activity. More than 370 flavonoid compounds were isolated from genus *Erythrina*, including flavones, flavonols, flavanones, chalcones, isoflavans, isoflav-3-enes, neoflav-3-ene, isoflavanones, isoflavones, pterocarpans, coumestans, arylcoumarins, coumaronochromones, arylbenzofurans, and biflavonoids.

1. Introduction

People around the world have extensively used naturally occurring substances for health purposes. In the past few decades, natural products gained much interest and played important roles in the treatment of many diseases. Natural products represent a rich source of new drugs and drug leads because they hold a high structural and chemical diversity not found in synthetic compounds (Lahlou, 2007). Flavonoids are a group of naturally occurring compounds with variable phenolic structures (Kumar and Pandey, 2013). They are well known for their various biological activity, that was attributed to their high antioxidant activity (Pinheiro and Justino, 2012). However, recent studies highlighted the potential of flavonoids as an anti-inflammatory agent and showed their importance in the inhibition of different pro-inflammatory mediators (Serafini et al., 2010), which explained the mechanism by which they exert their therapeutic effects. Flavonoids gained much attention in managing metabolic syndromes, cancers, cognitive and immune system disorders (Kumar and Pandey, 2013; Macready et al., 2009).

Genus *Erythrina* belongs to family Fabaceae and comprises over 130 species. Plants of this genus are cultivated in different countries and they are widely distributed in the tropical and subtropical areas around the world. *Erythrina* species are cultivated particularly as an ornamental, shade and soil improvement trees. *Erythrina americana* Mill. is easily propagated by vegetative means as well as by seeds (Kumar et al., 2010). *Erythrina lysistemon* Hutch. is cultivated in Egypt as an ornamental plant (El-Masry et al., 2002). *Erythrina* is derived from the Greek word “erythros”, which means red, the most common color of *Erythrina* flowers. However, some species possess orange and yellow flowers. It is occasionally referred to as the “coral tree” as some of the species have coral-colored flowers (de Araújo-Júnior et al., 2012). Traditionally, genus *Erythrina* has been widely used in the treatment of various

Abbreviations: 5-LOX, 5-lipoxygenase; AMPK, adenosine monophosphate-activated protein kinase; Bax, Bcl-2-associated X protein; BC, lymphoma cell line; Bcl-2, B-cell CLL/lymphoma 2; Caco2, human epithelial colorectal adenocarcinoma cells; CCRF-CEM, T lymphoblastoid cell line; COX, cyclooxygenase; DCM, dichloromethane; DGAT, diglyceride acyltransferase; ERE, estrogen response element; ERK, extracellular signal regulated kinase; ERα/β, estrogen receptors α/β; EtOAc, ethylacetate; H4IIE, hepatoma cell line; HCT116, human colorectal carcinoma cell lines; HeLa, human cervical carcinoma cell lines; HepG2, human liver carcinoma cell lines; hGLO I, human glyoxalase I; HIV, human immunodeficiency virus; HL-60, human promyelocytic leukemia cells; K562, human immortalised myelogenous leukemia; KB, human epidermoid carcinoma; LNCaP, androgen-sensitive human prostate adenocarcinoma cells; MAP, mitogen-activated protein; MAPK, mitogen activated protein kinase; MBC, minimum bactericidal concentration; MCF-7, human breast adenocarcinoma cell line; MDA-MB-231, human breast carcinoma cell lines; MeOH, methanol; MIC, minimum inhibitory concentration; MOLT-4, human, T lymphoblast, acute lymphoblastic leukemia; MRSA, methicillin resistant *Staphylococcus aureus*; NCI-H187, small cell lung carcinoma cell lines; NFF, human neonatal foreskin fibroblast; NF-kB, nuclear factor kappaB; PC3, human prostate cancer cell line; PLA2, phospholipase a2; PTP1B, protein tyrosine phosphatase 1b; RAW 264.7, abelson murine leukemia virus-induced tumor; RBA, receptor binder affinity; Sp., species; U87MG, glioblastoma cell line; VRE, vancomycin-resistant enterococcus; VRSA, vancomycin-resistant *Staphylococcus aureus*

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Table 1
Flavonoids isolated from *Erythrina* species and their studied activities.

no.	Compound Name	Occurrence (Solvent used for extraction)	Biological Activity	References
3.1. Flavones				
3.1.1. Flavones aglycone				
1.	6-Prenylapigenin	*E. vogelii* Hook.f. stem bark (DCM[a]:MeOH[b])		(Kamdem Waffo et al., 2006)
2.	Luteolin	*E. crista-galli* leaves (aqueous MeOH)		(Ashmawy et al., 2016)
3.	Vogelin C	*E. subumbrans* bark (DCM)	Antiplasmodial activity against *Plasmodium falciparum* (IC_{50} = 2.8 μg/ml) Cytotoxic against BC[c] cells (IC_{50} = 18.4 μg/ml)	(Rukachaisirikul et al., 2008)
		E. vogelii roots (DCM)		(Atindehou et al., 2002)
4.	Vogelin J	*E. vogelii* stem bark (DCM:MeOH)		(Kamdem Waffo et al., 2006)
5.	Carpachromene	*E. senegalensis* stem bark (DCM)	15-lipoxygenase (LOX) inhibitor (IC_{50} = 82 ± 7 μM)	(Togola et al., 2009)
		E. vogelii stem bark (DCM:MeOH)		(Kamdem Waffo et al., 2006)
6.	Atalantoflavone (Limonianin)	*E. sigmoidea* bark (MeOH)	Cytotoxic against CCRF-CEM[d] (IC_{50} = 44.69 μM), MDA-MB-231[e] (IC_{50} = 24.55 μM), HCT116[f] (p53+/+) (IC_{50} = 64.83 μM), U87MG[g] (IC_{50} = 106.49 μM), and HepG2[h] (IC_{50} = 88.99 μM) cell lines	(Kuete et al., 2014a)
		E. vogelii stem bark (DCM:MeOH)		(Kamdem Waffo et al., 2006)
7.	Neocyclomorusin	*E. sigmoidea* bark (MeOH)	Cytotoxic against CCRF-CEM (IC_{50} = 59.02 μM), MDA-MB-231 (IC_{50} = 78.51 μM), HCT116 (p53+/+) (IC_{50} = 75.44 μM), U87MG (IC_{50} > 91.72 μM), and HepG2 (IC_{50} > 91.72 μM) cell lines	(Kuete et al., 2014a)
8.	Salvigenin	*E. vogelii*		(Ali et al., 2010)
9.	Tetramethylisoscutellarein	*E. schliebenii* Harms leaves (MeOH)		(Nyandoro et al., 2017)
10.	Sinensetin	*E. schliebenii* leaves (MeOH)		(Nyandoro et al., 2017)
3.1.2. Flavones glycosides				
11.	Vitexin	*E. falcata* Benth. stem bark	Improve fear memory acquisition, neurocognitive disorders, memory acquisition and spontaneous recovery of fear	(de Oliveira et al., 2014)
		E. caffra flowers (EtOAc[i])		(El-Masry et al., 2010a)
12.	Isovitexin	*E. falcata* stem bark	Improve the acquisition of fear memory, neurocognitive disorders, memory acquisition and spontaneous recovery of fear	(de Oliveira et al., 2014)
		E. crista-galli leaves (aqueous MeOH)		(Ashmawy et al., 2016)
13.	Isovitexin-2″-β-D- glucopyranoside	*E. caffra* flowers (butanol)		(El-Masry et al., 2010a)
14.	Apigenin-7-*O*-rhamnosyl-6-*C*-glucoside	*E. crista-galli* leaves (aqueous MeOH)		(Ashmawy et al., 2016)
15.	Vicenin-1	*E. falcata* stem bark		(de Oliveira et al., 2014)
16.	Vicenin-2	*E. falcata* stem bark		(de Oliveira et al., 2014)
		E. caffra flowers (butanol)		(El-Masry et al., 2010a)
17.	Isoorientin	*E. crista-galli* leaves (aqueous MeOH)		(Ashmawy et al., 2016)
18.	Diosmetin-6-*C*-glucoside	*E. falcata* stem bark	Improvement of memory acquisition, and spontaneous recovery of fear.	(de Oliveira et al., 2014)
3.2 Flavonols				
3.2.1 Flavonols aglycone				
19.	3,7,4′-Trihydroxyflavone	*E. fusca* Lour. stem bark (MeOH) (Synonyms of *E. caffra* Blanco)	Inactive against MRSA[j] and *Staphylococcus aureus* Cytotoxic against KB[k] (IC_{50} = 10.39 μg/ml), MCF7[l] (IC_{50} = 21.76 μg/ml), and NCI-H187[m] (IC_{50} = 10.15 μg/ml) cell lines	(Innok et al., 2010)
3.2.2. Flavonols glycoside				
20.	Kaempferol-3-*O*-(2″-*O*-β-D-glucopyranosyl-6″-*O*-α-L-rhamnopyranosyl-β-D-glucopyranoside)	*E. abyssinica* flowers (0.1% HCl in MeOH)		(Kamusiime et al., 1996)
21.	Kaempferol-3-*O*-β-D-glucopyranosyl-(1→2)-β-D-glucopyranoside	*E. caffra* flowers (EtOAc)		(El-Masry et al., 2010a)
3.3 Flavanones				
22.	Liquiritigenin	*E. abyssinica* root bark (EtOAc)	No *in vitro* PTP1B[n] inhibitory activity (IC_{50} > 100 μM)	(Nguyen et al., 2011)
		E. addisoniae stem bark (DCM)	No cytotoxic activity against hepatoma cell line	(Watjen et al., 2008)
		E. fusca stem bark (EtOAc)	Antiplasmodial activity against *Plasmodium falciparum* (IC_{50} > 12.5 μg/ml)	(Khaomek et al., 2008)
		E. lysistemon stem wood (EtOAc)		(Juma and Majinda, 2005)
23.	Isobavachin	*E. sigmoidea* stem bark (MeOH)		(Ali et al., 2011)
		E. variegata roots (EtOH)	Inactive against *S. aureus* and *Mycobacterium smegmatis*	(Telikepalli et al., 1990)
24.	Glabrol	*E. subumbrans* stems (DCM)		(Rukachaisirikul et al., 2007a)

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