A Further Comprehensive Review on the Phytoconstituents from the Genus *Erythrina*

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(Received: August 22, 2019; Accepted: January 28, 2020; Published: January 30, 2020)

**Abstract:** *Erythrina* is a significant source of phytoconstituents. The aim of this review is to solicitude of classification, synthesis, and phytochemicals with biological activities of *Erythrina*. In our previous review on this genus (Hussain et al., 2016a) fifteen species (*Erythrina addisioniae, E. caribeae, E. indica, E. lattisima, E. melanacantha, E. mildbraeidi, E. poepigiana, E. stricta, E. subumbrians, E. veriagata, E. vespertilio, E. velutina, E. zeberi, E. zeyheri and E. americana*) have been studied and 155 molecules with chemical structures were reported. A further comprehensive review was done upon continuation on the same genus and thirteen species (*E. abyssinica, E. arborescens, E. berteroana, E. burtti, E. caffra, E. coralloids, E. crisata-galli, E. fusca, E. herbaceae, E. lysis, E. mulungau, E. speciosa and E. tahitensis*) of *Erythrina* have been studied and 127 compounds are reported as phytoconstituents with their chemical structure in this review. *Erythrina crisata-galli* and *E. lysis* consist of highest number of chemical constituents.

**Key words:** Phytoconstituents, classification, *Erythrina*, leguminoseae, biological properties.

**Introduction**

One hundred and ten species of shrubs and trees are present under the genus *Erythrina* (Family: Leguminosae). A total thirteen medicinal plants have been reviewed comprehensively in this study (Hussain et al., 2016a). *E. abyssinica* is a medium sized tree, 5-15 m in height, well branched and leaves are compounded. *E. arborescens* (Himalayan coral tree) is a deciduous tree growing up to 5 m tall; branches and trunk have been covered with prickles. *E. berteroana* (Coral bean) is a shrub like tree (10 m tall) and trunk (48 cm) having red flower. *E. burtti* is a flowering plant found in Kenya and Ethiopia. *E. caffra* is a medium to large sized deciduous tree, 9-12 × 7-11 m in height. *E. coralloides* (Nacked coral tree) is a fast growing deciduous tree 30 ft in height with bright red flowers in early spring. *E. crisata-galli* is a deciduous tree growing to 15-20 ft tall having dark furrowed bark and green leaflets. *E. fusca* (Coral bean) is deciduous tree having spiny bark and light orange flowers. *E. herbaceae* (Coral bean) is a shrub (20 ft in height) but sometimes it may be smaller and leaves are semi deciduous 6-8 inch long. *E. lysis* is a small to medium sized deciduous and lovely tree (10 m in height) with brilliant and spreading crown red flowers. *E. mulungu* (Ornamental tree) is a medicinal plant native to Brazil and South America. *E. speciosa* is a tree native to Brazil, cultivated, and introduced populations in Africa and India. *E. tahitensis* is a species of legume (Family: Fabaceae) endemic to French Polynesia. Species of *Erythrina* have been used as a traditional medicine in sedative, febrifuge, anti-asthmatic, anti-epileptic, convulsion, fever, inflammation, bacterial infection, insomnia, helminthiasis, cough, cuts, and wounds (Kumar et al., 2010).

**Classification of Erythrina alkaloids:** Depending on skeleton, two types of *Erythrina* alkaloids are present i) Erythrinane (I) consisting of a 6,5,6,6 Indoloisoquinoline and ii) Homoerythrinane (2)

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DOI: [https://doi.org/10.3329/bpj.v23i1.45321](https://doi.org/10.3329/bpj.v23i1.45321)
containing 6, 5, 7, 6 Indolobenzazepine skeleton (Figure 1). On the basis of D ring present in the skeleton, Erythrina alkaloids are classified as aromatics (3, 4, 5, 6, 7, 8, 9, 10), hetero-aromatics (11, 12, 13) and non-aromatics (14, 15) (Amer et al., 1991; Barton et. al., 1970; Barton et al., 1974; Carmack et al., 1951; Folkers et al., 1939, 1940a, 1940b, 1940c, 1937; Garin-Aguilar et al., 2000; Maier et al., 1097, 1999; Soto-Hernandez et al., 2012) (Figure 2).

\[
3, R^1 = R^2 = CH_3, n = 1: \text{Erythrine} \\
4, R^1 = R^2 = H, n = 1: \text{Eryspine} \\
5, R^1 = CH_3, R^2 = H, n = 1: \text{Erysovine} \\
6, R^1 = H, R^2 = CH_3, n = 1: \text{Erysodine} \\
7, R^1 = R^2 = CH_3, n = 2: \text{Schellhammeridine} \\
8, R = H, n = 1: \text{Erythramidine} \\
9, R = \beta-\text{OH}, n = 1, \text{Erythrinine} \\
10, R = H, n = 2, \text{Schellhammeridione} \\
11: \text{Erymelanthine} \\
12: \text{Holidine} \\
13: \text{Scaginoidine} \\
14: \text{Erythroidine} \\
15: \text{Cocculolidine}
\]

Figure 1. Erythrina alkaloids depending on skeleton

Figure 2. Classification of Erythrina alkaloids on the basis of D ring present.

**Biosynthesis of Erythrina alkaloids:**

Angiosperms is the key source of alkaloids, but it can be exists in animals as well as in microorganisms, insects, plants, and marine organism. Alkaloids are secondary metabolites that consist of secondary, tertiary, and quaternary nitrogen atoms in their molecular formula. Alkaloids have been used as medicines and in the recovery of poison. Metabolically, alkaloids are playing a significant function in the physiology at organism and plants. Three types of alkaloids are presents such as true, proto, and pseudo-alkaloids. Different bio-synthetic pathway of alkaloids had been offered, but the objective of this review is the demonstration of a bio-
synthetic pathway of *Erythrina* alkaloid. According to the Maier and Soto-Hernandez (Maier et. al., 1997, 1999; Soto-Hernandez et. al., 2012) *Erythrina* alkaloid, Δ³-Erythratinone (24) can be synthesized from the starting material (S)-Norriticuline (16) through synthesis of few intermediate products such as Norisosalutaridine (17), Noramurine (18), Neospirinic cation (20), and Diallylic cation (23) (Scheme 1).

Scheme 1. Synthetic pathway of *Erythrina* alkaloids
Chemical synthesis of the Erythrinane alkaloid:
Erythrinane alkaloid Erysodienone (30) can be synthesized from the precursor of S-Norprotosinomenine (25) with the synthesis of some intermediate compounds such as Neoproaporphine (26), (Z)-2,12-Dimethoxy-6,9-dihydro-5H-dibenzothiazine-3,11-diol (27), Dibenazonine (28), and Dibenazonine dione (29) (Soto-Hernansez et al., 2012; Cui et al., 2009) (Scheme 2).

![Scheme 2. Synthesis of Erythrinane alkaloid.](image)

Phytoconstituents: A total thirteen species of Erythrina have been studied and ninety six molecules (31-127) with chemical structures are reported in this review as bioactive compounds (Figure 3-15).

Erythrina abyssinica: A bunch of chemical compounds such as Abyssinone A (31), Abyssinone B (32), Abyssinone C (33), Abyssinone D (34), Abyssinone V (35), Erythribysins A (36), Erythribysins B (37), Erythribysins C (38), Eryvarin K (39), Neurautenol (40), Erybraedin B (41), 3,9-Dihydroxy-4-prenyl-[6αR:11αR]-pterocarpan (42), Folitenol (43), Erybraedin D (44), Erysulbin E (45), Erybraedin C (46), Phaseollidin (47), Sophora pterocarpan A (48), Erythribysin II (49), and Erystagallin (50) were reported from E. abyssinica (Figure 3) (Cui et al., 2008; Kabenei et al., 2011; Nguyen et al., 2009).
**Erythrina arborescens**: Eight phytochemicals were reported from *E. arborescens* for example (+)-Erysotramidine (51), (+)-11-β-Hydroxyerysotrine (52), (+)-Erythrascine (53), (+)-Erytharbine (54), (+)-Eryosphorine chloride (55), (+)-Erysodinophorine hydroxide (56), (+)-Erysopinophorine hydroxide (57), and (+)-Isoerysopinophorine hydroxide (58) (Figure 4) (Amer et al., 1991).

![Figure 3. Molecules from Erythrina abyssinica](image1)

![Figure 4. Chemical constituents from Erythrina arborescens.](image2)
**Erythrina berteroana**: The reported chemical compounds from this plant are (+)-11-Hydroxyerythratidine (59), (+)-Hydroxyerysosalvine (60), (+)-11-Hydroxyerysotine (61), (+)-α-Erythroidine (62), (+)-β-Erythroidine (63), (+)-8-Oxo-α-erythroidine (64), and (+)-8-Oxo-β-erythroidine (65) (Figure 5) (Amer et al., 1991).

Figure 5. Phytoconstituents from *Erythrina berteroana*

Figure 6. Secondary metabolites from *Erythrina burttii*
**Erythrina burttii**: The isolated bioactive moieties from this medicinal plants are Abyssinone V (35), Bruttinol-A (66), Burtinol-A diacetate (67), Bruttinol-B (68), Bruttinol-B acetate (69) Bruttinol-C (70), Bruttinol-C diacetate (71), Eryvarin-H (72), Eryvarin-H diacetate (73), Bruttinol-D (74), Bruttinol-D diacetate (75), Abyssinone-V-4’-methyl ether (76), Calopocarpin (77), Alpinumisoflavone (78), Erythrabissin-II (49), Isobavach (79), Phaseollidin (47), Phaseollin (80), Burtinone (81), Neurautenol (40), 4’-O-Methylsigmoidin (82), Bidwillon A (83), Erythinasinate (84), 7’-O-Methyluttenone (85), Burttinonedehydrate (86), 8-Prenylluttenone (87), 3-O-methylcalopocarpin (88), and Genistein (89) (Figure 6) (Yenesew et. al., 2002, 1998, 2003, 2012; Hussain, 2018).

**Erythrina caffra**: Four secondary metabolites such as (+)-Erysotrine (90), (+)-Erysodine (91), (+)-8-Oxo-erysodine (92), and (+)-11-Methoxyerysopine (93) were reported from this plants (Figure 7) (Amer et. al., 1991; Taria et. al., 1994).

![Figure 7. Molecules from Erythrina caffra.](image)

![Figure 8. Compounds from Erythrina coralloides.](image)

![Figure 9. Constituents from Erythrina crista-galli](image)
Erythrina coralloides: The reported three isolated phytochemicals from this plant are (+)-Erythraline (94), (+)-Erysopine (4), and (+)-Erythritidine (95) (Figure 8) (Amer et al., 1991; Soto-Hernandez et al., 2012; Hussain, 2018; Taria et al., 1994).

Erythrina crista-galli: A group of chemical moieties having biological properties reported from this plant are Cristanines A (96), Cristanines B (97), Erythrate (98), Crystamidine (99), Erysovine (5), Erythraline (3), 8-Oxo-erythraline (100), Erythrine (101), 8-Oxo-erythrine (102), Erythratidine (103), Epi-erythratidine (104), Hypaphorine (105), and Lupeol (106) (Figure 9) (Amer et al., 1991; Taria et al., 1994; Miquel-Chavez et al., 2006).

Erythrina fusca: A set of isolated phytoconstituents from this plant are Erythraline (3), Epi-erythratidine (104), Fuscacarpans A (107), Fuscacarpans B (108), Fuscacarpans C (109), Sandwicensin (110), Erythribyssins A (36), Erythrabissin I (111), Demethylmedicarpin (112), Eryvarin D (113), Erypoegin (114), Hydroxycristacarpone (115), Orientanol A (116), Scandenone (117), Genistein (89), Liquiritigenin (118), Isoliquiritinigen (119), Vestinone (120), and 3,7,4′-Trihydroxyflavone (121) (Figure 10) (Amer et al., 1991; Ozawa et al., 2010; Innok et al., 2010).

Erythrina herbaceae: The isolated chemical compounds from this plant are Erybacin A (122), Erybacin B (123), 6-formyl-2,2-dimethyl-2H-chromene (124), Eryvariestyrene (125), Glyasperin F (126), Eryvarin H (72), Bidwillol A (127), Phaseollinisoflavan (128), Erythbidin A (129), Phaseollidisoflavan (130), Eryvarin L (131), and Glabrocoumarone A (132) (Figure 11) (Tanaka et al., 2010, 2003, 2001).

Erythrina lysistemon: (+)-Erythristemine (133), (+)-11-β-Methoxyglucoerysorovine (134), (+)-11-Hydroxyerovovine (135), (+)-11-Methoxyerovovine (136), (+)-Glucoersodine (137), (+)-11-β-
Methoxyglucoerysodine (138), (+)-Rhamnoerysodine (139), (+)-11-α-Hydroxyerysodine (140), (+)-11-β-Hydroxyerysodine (141), (+)-11-β-Methoxyerysodine (142), and (+)-8-Oxo-11-β-methoxyerythraline (143) are reported from this plant (Figure 12) (Amer et al., 1991).
**Erythrina mulungu:** Seven reported molecules from this plant are Erysotrine (90), Erysovine (5), Hypaphorine (105), (+)-Erythravine (144), (+)-11-α-hydroxy-erythravine (145), (+)-Erysotrine N-oxide (146), and (+)-Erythartine N-oxide (147) (Figure 13) (Amer et. al., 1991; Yenesew et. al., 1998; Sarragiotto et. al., 1981).

![Chemical compounds from Erythrina mulungu.](image)

**Erythrina speciosa:** The elucidated chemical compounds from this plant are Erysotrine (90), Erythartine (148), Erysovine (149), Erysidone (149), Erysovine (150), Erythsonine (151), E-erythrocarina (152), E-erythsonin (153), and Nororientaline (154) (Figure 14) (Faria et. al., 2007).

![Chemical compounds from Erythrina speciosa.](image)

**Erythrina tahitensis:** (+)-8-Oxoerysodine (155), (+)-11-Oxo-Erysovine (156), and (+)-11-Oxo-erythropine (157) were isolated as bioactive compounds from this plant (Amer et. al., 1991).

![Chemical compounds from Erythrina tahitensis.](image)
Biological properties: Medicinal plants are the pioneer source of biologically active constituents (Hussain 2019a, 2019b, 2018; Hussain et. al., 2010, 2011, 2008, 2016b; Billah et. al., 2013; Ismail et. al., 2010). As an indigenous medicine, many species of Erythrina have been used as eyewashes, wounds, pain relief of arthritis, and relaxants agents (Garin-Aguilar et. al., 2000). The pharmacological properties of the derived molecules from the medicinal plants studied in this review are summarized in Table 1.

Table 1. Biological properties of the elucidated derivatives from the medicinal plants.

<table>
<thead>
<tr>
<th>Phytoconstituents</th>
<th>Biological properties</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+)-Erythraline and Erythrine</td>
<td>Radio-labeled activity</td>
<td>Maier et. al., 1999</td>
</tr>
<tr>
<td>Abyssinone V</td>
<td>Antimicrobial (Plasmodium falciparum)</td>
<td>Kabenei et. al., 2011</td>
</tr>
<tr>
<td>Abyssinone A, Abyssinone B, Abyssinone C, and Abyssinone D</td>
<td>Cytotoxic and PTP1B inhibition</td>
<td>Cui et. al., 2008; Nguyen et. al., 2009</td>
</tr>
<tr>
<td>Bruttinol-A, Bruttinol-B, and Bruttinol-D</td>
<td>Anti-plasmodial and radical scavenging</td>
<td>Yenesew et. al., 2012</td>
</tr>
<tr>
<td>Erythraline, Erythrine, and Hypaphorine</td>
<td>LPS induced NO production and cell viability in RAW264.7 macrophase</td>
<td>Ozawa et. al., 2010</td>
</tr>
<tr>
<td>Fuscacarpans-A, Fuscacarpans-B, and Fuscacarpans-C</td>
<td>Antibacterial, antiplasmodial, and cytotoxic</td>
<td>Innok et. al., 2010</td>
</tr>
<tr>
<td>Erybacin A and Erybacin B</td>
<td>Antibacterial (Staphylococcus aureus) and bactericidal (MRSA)</td>
<td>Tanaka et. al., 2010</td>
</tr>
<tr>
<td>Abyssinone-V-4′-methyl ether and Alpinumisoflavone</td>
<td>Estrogenic</td>
<td>Nde et. al., 2012</td>
</tr>
<tr>
<td>Genistein</td>
<td>Antimicrobial</td>
<td>Redko et. al., 2007</td>
</tr>
<tr>
<td>(+)-Erythrivane, (+)-11-α-hydroxy-erythrivane</td>
<td>Anticonvulsant and anxiolytic</td>
<td>Rosa et. al., 2012</td>
</tr>
<tr>
<td>β-erythroidine</td>
<td>Radio-labeled activity regarding 14C-tyrosine</td>
<td>Mantle et. al., 1984</td>
</tr>
<tr>
<td>Erysotramidine and Erysotine N-oxide</td>
<td>Anti-oxidant</td>
<td>Tanaka et. al., 2008</td>
</tr>
<tr>
<td>Erysoidine</td>
<td>DPPH radical scavenging</td>
<td>Juma et. al., 2004</td>
</tr>
<tr>
<td>Lupeol</td>
<td>Antiplasmodial</td>
<td>Chukwujekwa et. al., 2016</td>
</tr>
</tbody>
</table>

Conclusion

A total thirteen species of Erythrina have been studied. Structurally distinctive including numerous diversified molecules have been reported from this genus. Our study explored that Erythrina genus can be an outstanding source of phytochemicals as well as medicinal agents.

References


