Bangladesh Pharmaceutical Journal ***23****(1): 65-77, 2020 (January)* **- Review paper**

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

Mohammad Musarraf Hussain

Department of Pharmacy, Faculty of Life and Earth Sciences, Jagannath University
Dhaka-1100, Bangladesh

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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 addisoniae, E. caribeae, E. indica, E. lattisima, E. melanacantha, E. mildbraedii, E. poeppigiama, E. stricta, E. subumbrans, 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. burttii, E. caffra, E. coralloids, E. crista-galli, E. fusca, E. herbaceae, E. lysistemon, E. mulungu, 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 crista-galli* and *E. lysistemon* 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. burttii* 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. crista-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. lysistemon* 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 (**1**) consisting of a 6,5,6,6 Indoloisoquinoline and ii) Homoerythrinane (**2**)

Correspondence to: Mohammad Musarraf Hussain. Email: mmhussain@pharm.jnu.ac.bd and m.musarraf.hussain@gmail.com, ORCID: 0000-0001-9270-0474.

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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).

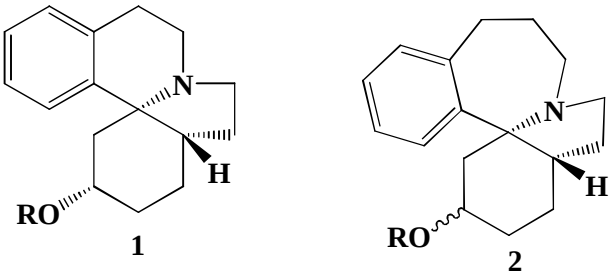


Figure 1. *Erythrina* alkaloids depending on skeleton

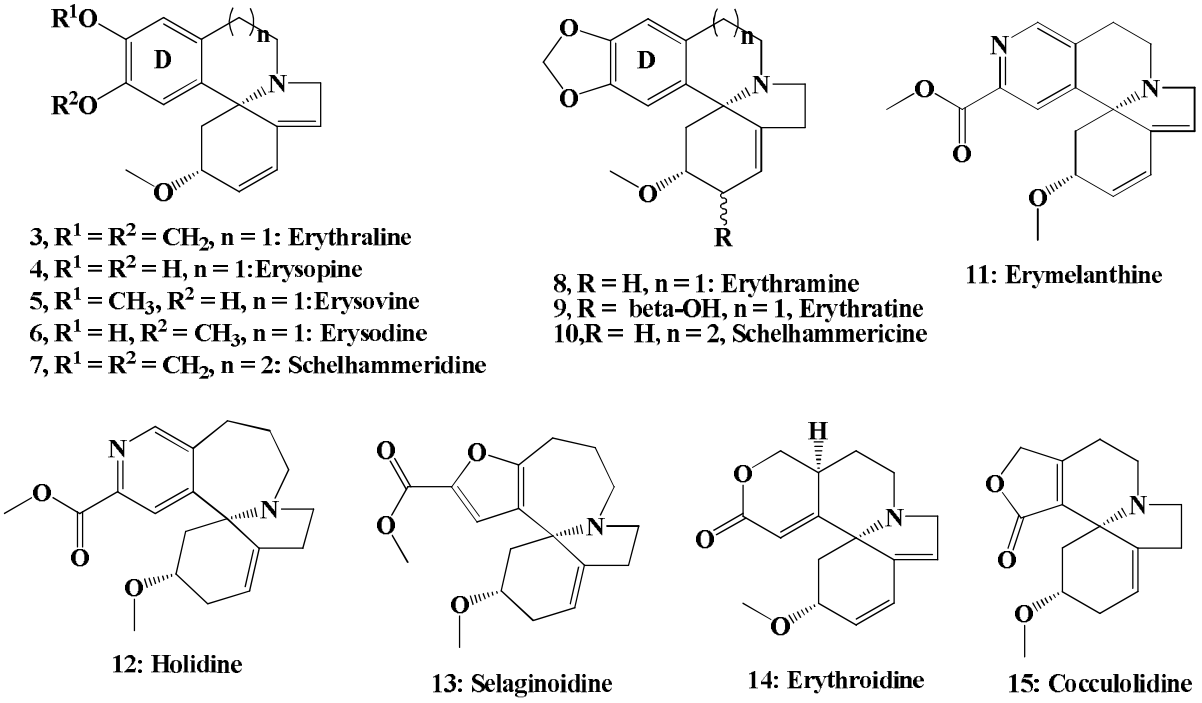
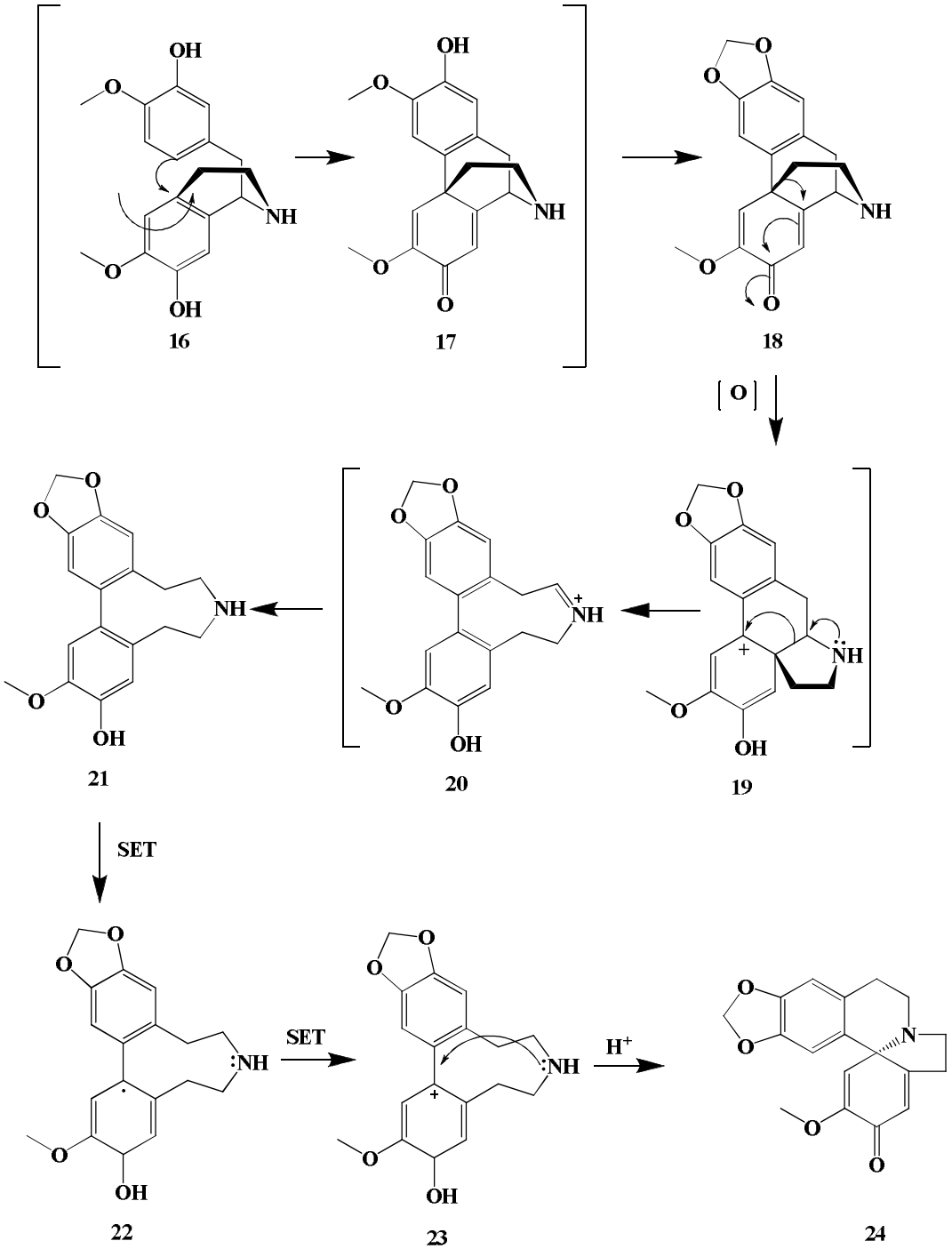


Figure 2. Classification of *Erythrina* alkaloids on the basis of D ring present.

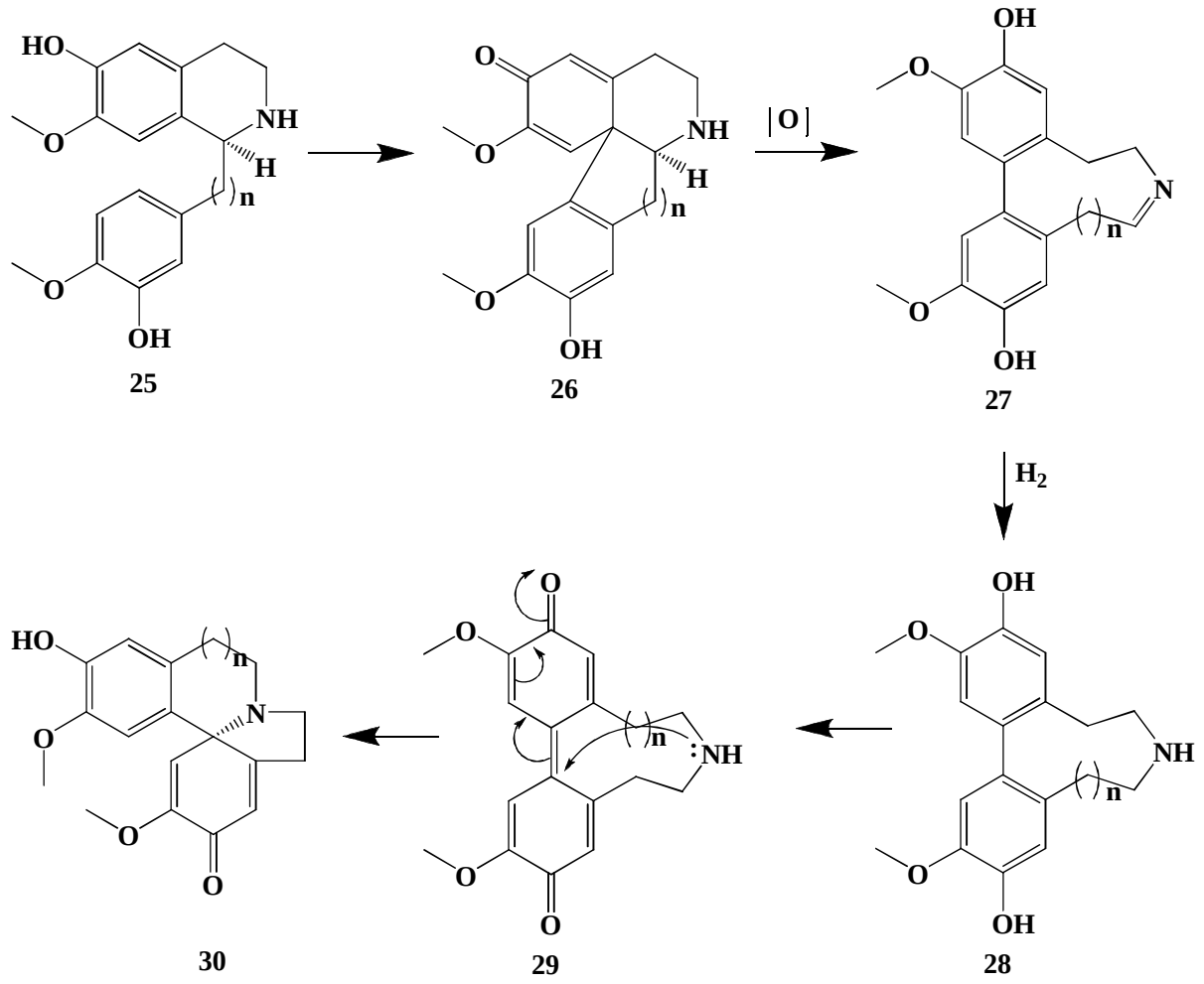
Biosynthesis of Erythrina alkaloids: Angiosperms is the key source of alkaloids, but it can be exists in animals as well as in microorganisms, insects, plants, and marine organism. Alkaloids are secondary metabolites that consist of secondary, tertiary, and quaternary nitrogen atoms in their molecular 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, Δ^3-Erythratinone (**24**) can be synthesized from the starting material (*S*)-Norreticuline (**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 form the precursor of *S*-Norprotosinomenine (**25**) with the synthesis of some intermediate compounds such as Neoproaporphine (**26**), (*Z*)-2,12-Dimethoxy-6,9-dihydro-5*H*-dibenzo-[d,f]-azonine-3,11-diol (**27**), Dibenzazonine (**28**), and Dibenzazonine dione (**29**) (Soto-Hernansez *et. al.*, 2012; Cui *et. al.*, 2009) (Scheme 2).



Scheme 2. Synthesis of Erythrinane alkaloid.

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**), Erythribyssins A (**36**), Erythribyssins B (**37**), Erythribyssins C (**38**), Eryvarin K (**39**), Neurautenol (**40**), Erybraedin B (**41**), 3,9-Dihydroxy-4-prenyl-[6a*R*:11a*R*]-pterocarpan (**42**), Folitenol (**43**), Erybraedin D (**44**), Erysubin E (**45**), Erybraedin C (**46**), Phaseollidin (**47**), Sophora pterocarpan A (**48**), Erythrabyssin-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**), (+)-Erysophorine chloride (**55**), (+)-Erysodinophorine hydroxide (**56**), (+)-Erysopinophorine hydroxide (**57**), and (+)-Isoerysopinophorine hydroxide (**58**) (Figure 4) (Amer *et. al.*, 1991).

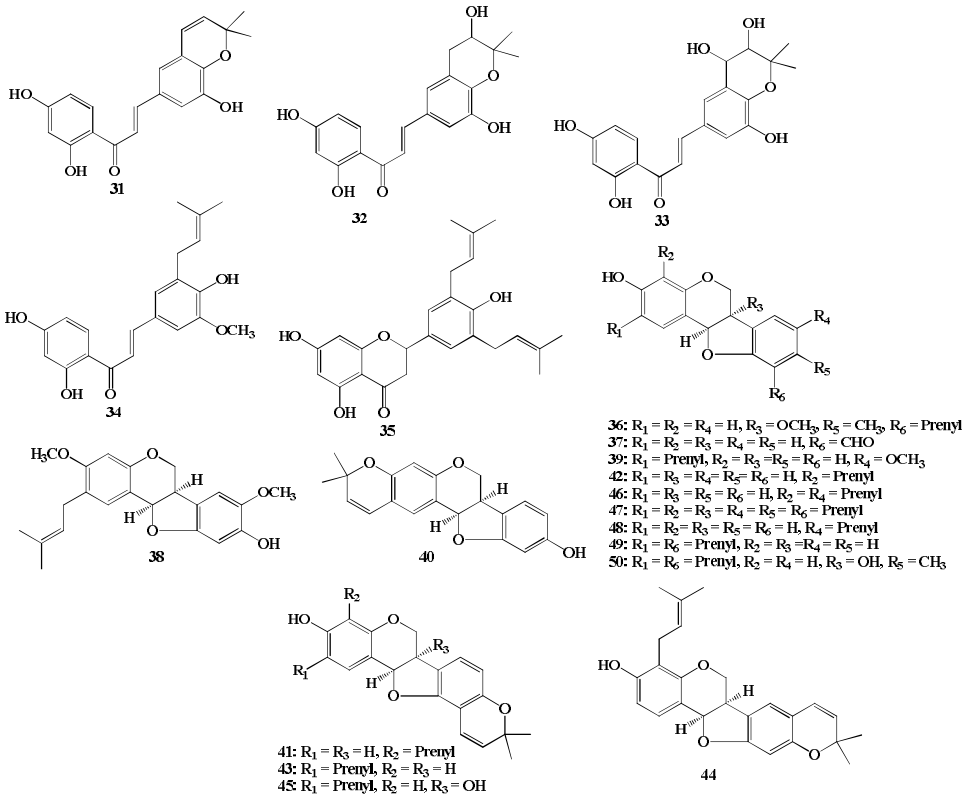


Figure 3. Molecules from *Erythrina abyssinica*

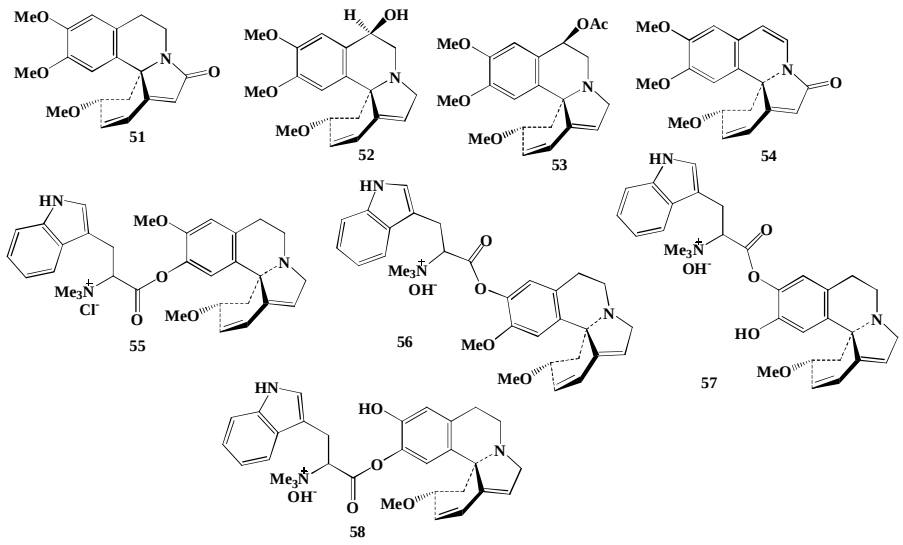


Figure 4. Chemical constituents from *Erythrina arborescens.*

Erythrina berteroana: The reported chemical compounds from this plants 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).

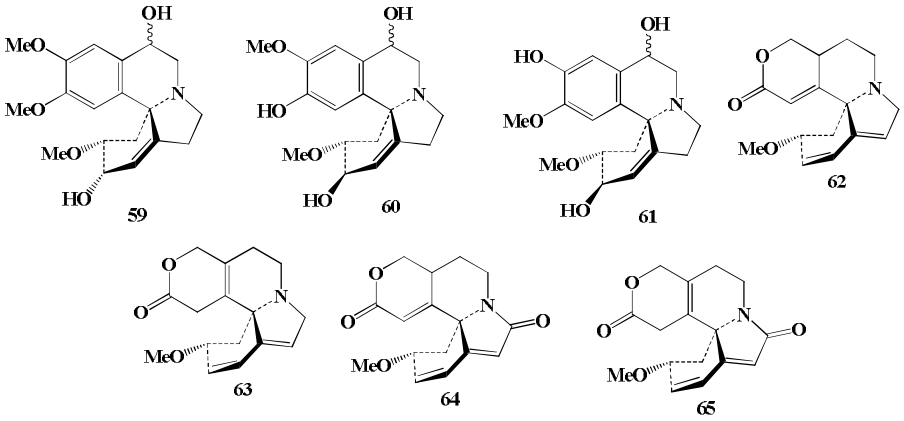


Figure 5. Phytoconstituents from *Erythrina berteroana*

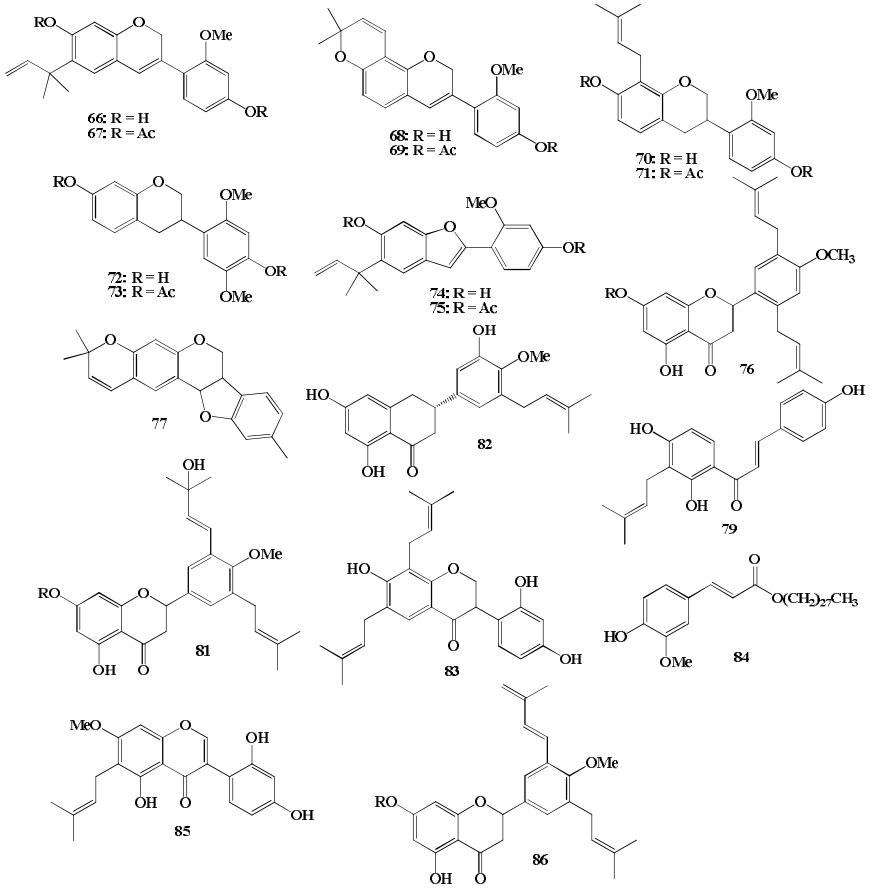


Figure 6. Secondary metabolites from *Erythrina burttii*

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**), Isobavachalcone (**79**), Phaseollidin (**47**), Phaseollin (**80**), Burttinone (**81**), Neurautenol (**40**), 4´-O-Methylsigmoidin (**82**), Bidwillon A (**83**), Erythrinasinate (**84**), 7´-O-Methyllutenone (**85**), Burttinonedehydrate (**86**), 8-Prenyllutenone (**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).

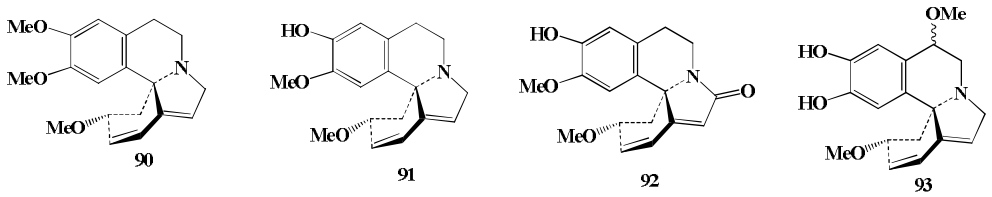


Figure 7. Molecules from *Erythrina caffra.*

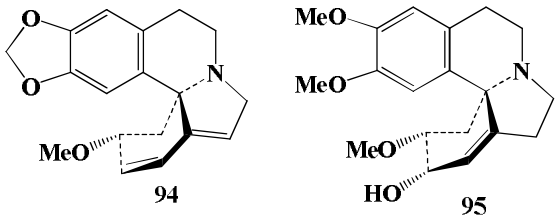


Figure 8. Compounds from *Erythrina coralloides.*

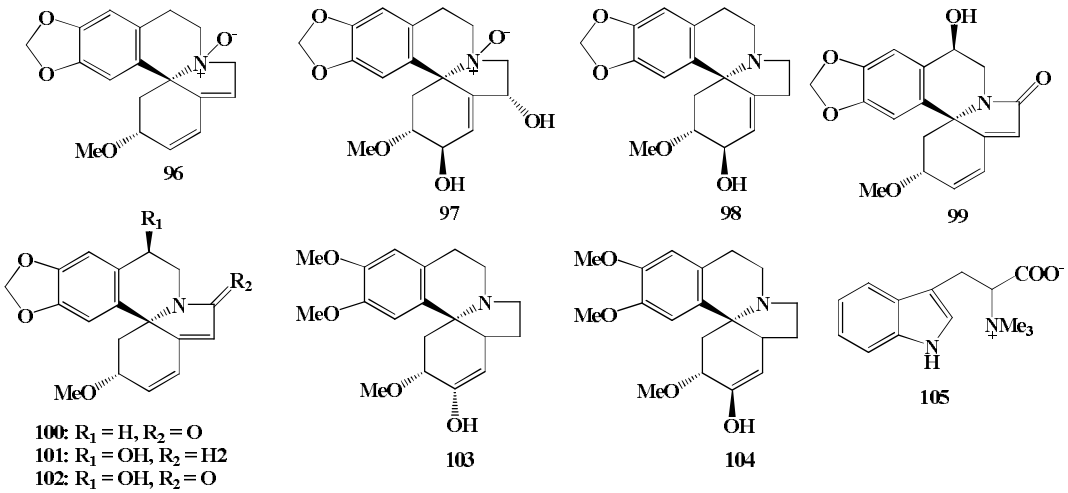


Figure 9. Constituents from *Erythrina crista-galli*

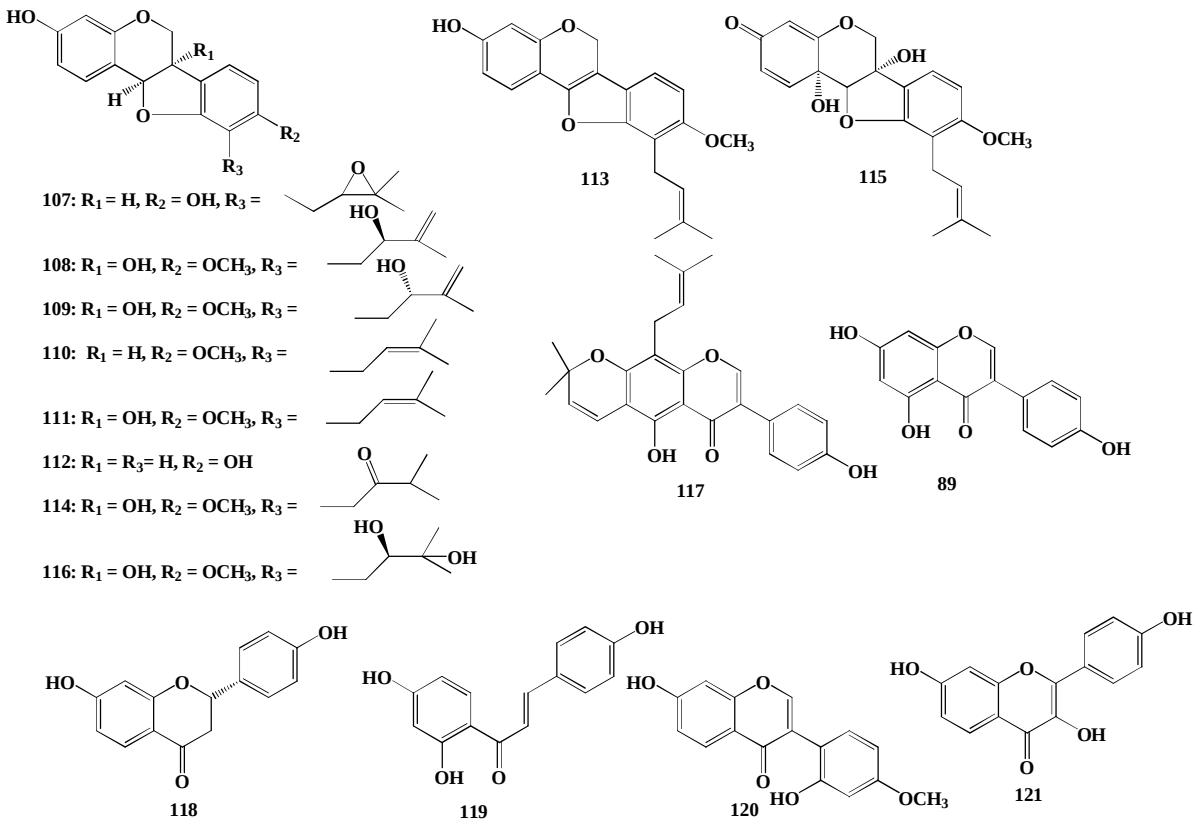


Figure 10. Chemical compounds from *Erythrina fusca*

Erythrina coralloides: The reported three isolated phytochemicals from this plant are (+)-Erythraline (**94**), (+)-Erysopine (**4**), and (+)-Erythratidine (**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 plants are Cristanines A (**96**), Cristanines B (**97**), Erythratine (**98**), Crystamidine (**99**), Erysovine (**5**), Erythraline (**3**), 8-Oxo-erythraline (**100**), Erythrinine (**101**), 8-Oxo-erythrinine (**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**), Isoliquiritigenin (**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-2*H*-chromene (**124**), Eryvariestyrene (**125**), Glyasperin F (**126**), Eryvarin H (**72**), Bidwillol A (**127**), Phaseollinisoflavan (**128**), Erythbidin A (**129**), Phaseollidinisoflavan (**130**), Eryvarin L (**131**), and Glabrocoumarone A (**132**) (Figure 11) (Tanaka *et. al.*, 2010, 2003, 2001).

Erythrina lysistemon: (+)-Erythristemine (**133**), (+)-11-β-Methoxyglucoerysovine (**134**), (+)-11-Hydroxyerysovine (**135**), (+)-11-Methoxyerysovine (**136**), (+)-Glucoerysodine (**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).

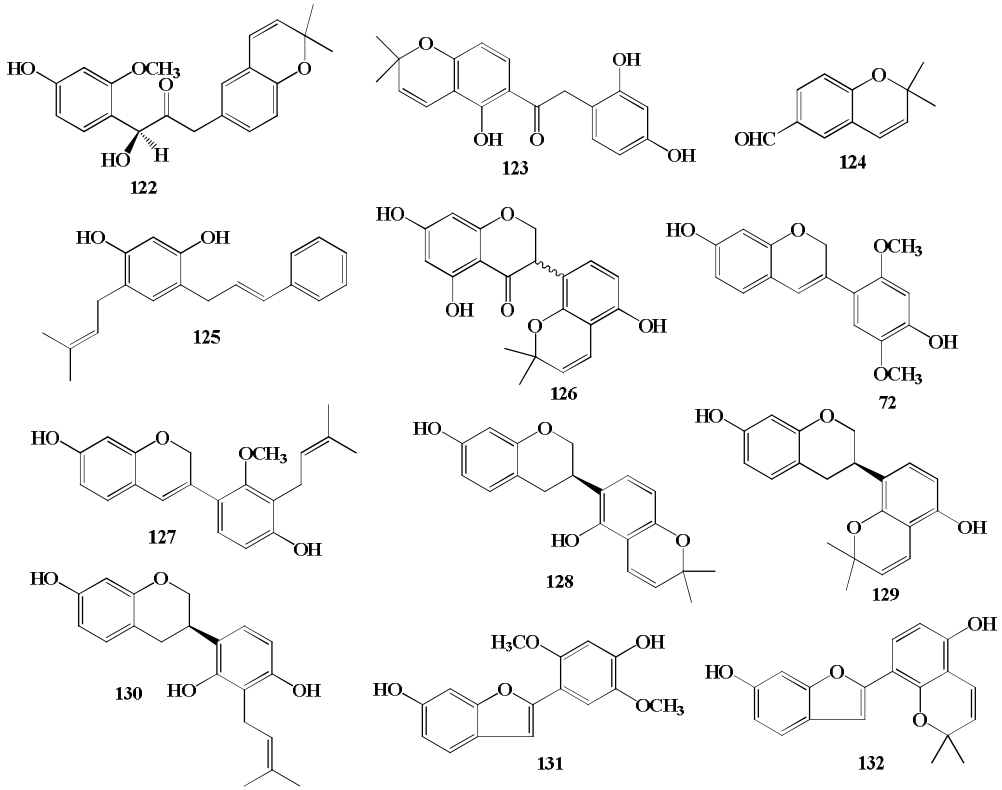


Figure 11. Phytochemicals from *Erythrina herbaceae*

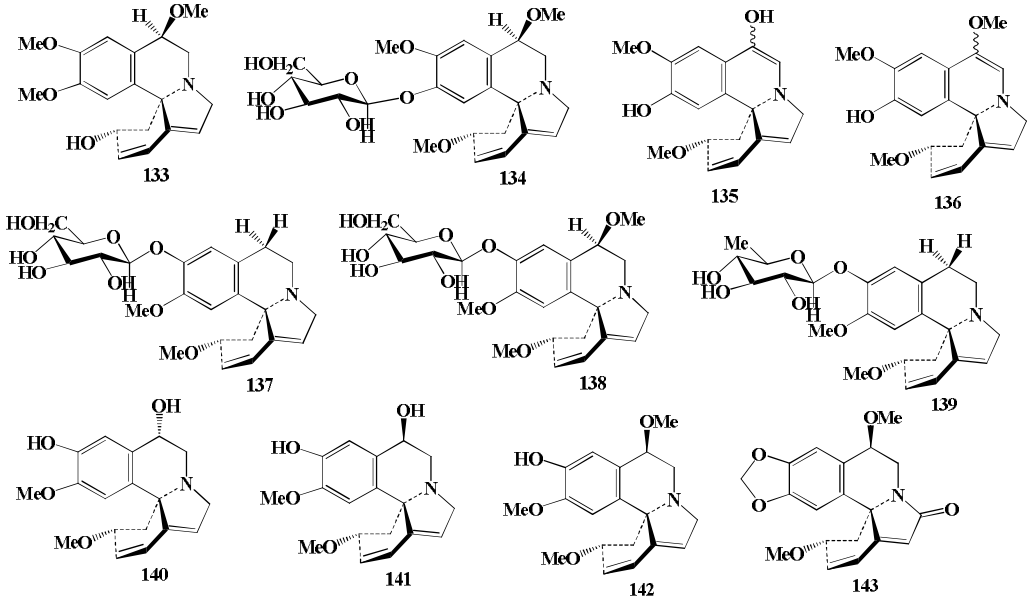


Figure 12. Phytoconstituents from *Erythrina lysistemon*

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 (+)-Erythrartine *N*-oxide (**147**) (Figure 13) (Amer *et. al.*, 1991; Yenesew *et. al.*, 1998; Sarragiotto *et. al.*, 1981).

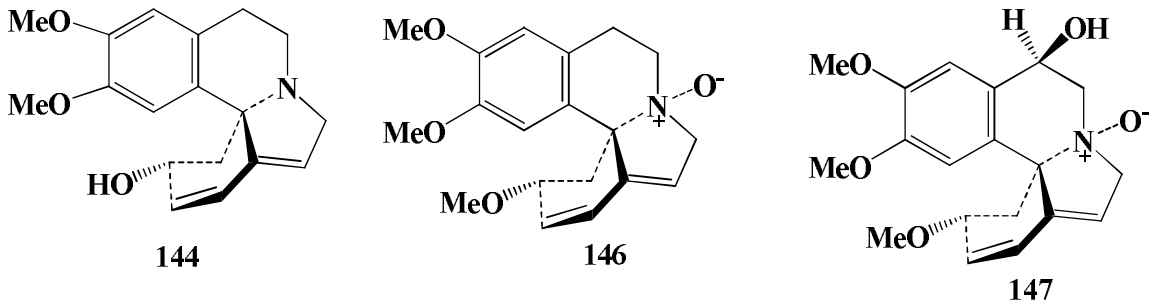


Figure 13. Chemical compounds from *Erythrina mulungu.*

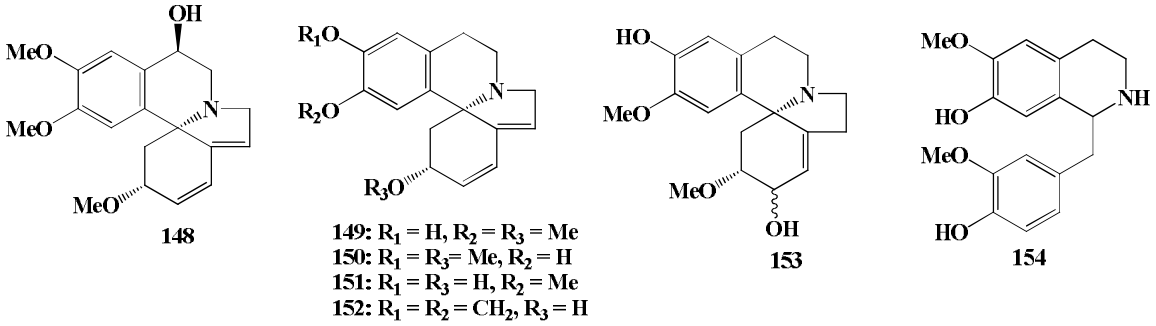


Figure 14. Chemical compounds from *Erythrina speciosa.*

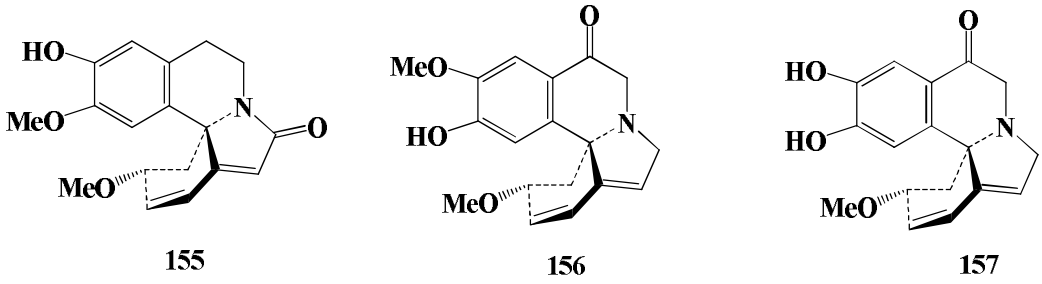


Figure 15. Chemical compounds from *Erythrina tahitensis.*

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

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

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.

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

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.

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