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# A Phytochemical and Ethnopharmacological Review of the Genus *Erythrina*

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## 1. Introduction

Considered in ancient times as a connection to the divine, the use of this medicinal plant is as old as human civilization itself. Whole nations dominated its secrets, often associated with magic and religious rites, searching in nature's resources to improve life conditions, and increase chances of survival (Herbarium, 2008).

In 1978, the World Health Organization (WHO) recognized folk medicine and its beneficial effects to health, during the *Alma Ata* conference, which published in 1985 that approximately 80% of the global population, resorted to traditional medicine as their primary health treatment (Herbarium, 2008). Medicinal plants have been used as a means of curing or preventing diseases, now called phytotherapy, in all regions of the world, with regional variations due to the influence of cultural characteristics of the population, as well as its flora, soil and climate (Lewinsohn, 2003).

Since the nineteenth century, humanity discovered the endless and diverse therapeutic arsenal present in medicinal plants, due to the discovery of active substances that in their natural state or after chemical transformation showed biological activity, and often already confirmed by popular use and/or proven scientifically (Miguel & Miguel, 2004).

According to Yamada (1998) it is necessary to carry out more studies and to propagate medicinal plant utilization as a way to diminish the costs of public health programs since the utilization of these plants may constitute a very useful therapeutic value due their efficacy coupled with low operating costs and the relative ease of obtaining the plants (Matos, 1994).

According to Brazilian legislation, a new herbal medicine can be introduced to the market in two forms: as a finished product - industrially produced, or as an official product - manufactured in pharmacies. Both forms should ensure quality, safety and efficacy of the herbal medicines supplied to the consumer. On the other hand, medicinal plants sold at popular markets or obtained directly from farmers at an informal market, have no guarantee provided by law, especially with regards to safety and efficacy (Herbarium, 2008). However we cannot rule out the cultural importance that popular knowledge inputs, being transmitted from generation to generation.

The WHO strategy on traditional medicine for the period of 2002-2005 has brought as one of its objectives, the strengthening of traditional remedies by placing them in the National Health Systems through policies and programs determined by their respective governments. The National Policy on Integrative and Complementary Practices of the Brazilian Unified Health System (SUS, *Sistema Único de Saúde*) (2006), for example, fulfills these requests by proposing the inclusion of medicinal plants, phytotherapy, homeopathy, traditional Chinese medicine, acupuncture, hydrotherapy and crenotherapy as therapeutic options for the SUS. Another example is the Brazilian National Policy on Medicinal Plants and Herbal Medicines, which includes as one of its guidelines the promotion and recognition of popular practices in the use of herbal and home remedies. Therefore, a strategy that can be used to meet this demand proposed by the federal government is to conduct a survey of plants used by communities in order to strengthen with the establishment a list of Medicinal Plants of Interest to SUS (RENISUS), which aims to give priority to the naturally occurring species of regions or to those easily cultivated. In this context, the Brazilian Ministry of Health released the RENISUS list, containing 71 species of medicinal plants for therapeutic use (<http://portal.saude.gov.br/portal/arquivos/pdf/RENISUS.pdf>).

## 2. The Fabaceae family

Also known as a sub-family of Leguminosae, the Fabaceae family is one of the largest botanical families and widely distributed around the world, spread out over temperate, tropical and cold regions. Thus family is composed of 32 tribes, whose genera are chemically represented by a variety of flavonoid skeletons, notably pterocarpanes and isoflavones. There are about 650 genera comprising about 18,000 species (Polhil & Raven, 1981). The genus *Erythrina* is represented by about 290 species (Cronquist, 1981; <http://www.tropicos.org/Name/40005932>). The Fabaceae family produces valuable medicinal drugs, ornamental species, fodders plants, oil producing plants, insecticides and species with various other functions (Salinas, 1992).

## 3. The *Erythrina* Genus

The genus *Erythrina* is one among several genera from the Fabaceae family. The origin of the name *Erythrina* comes from the Greek word “erythros” which means red, alluding to the bright red flowers of the trees of the genus (Krukoff & Barneby, 1974). Over 130 species of “coral tree” belong to the genus *Erythrina*, which has been widely studied and are distributed in tropical and subtropical regions of the world. In South America, these species are present in Argentina, Bolivia, Paraguay, French Guiana, Colombia and Peru (Hickey & King, 1981). In Brazil the genus is spread throughout all of the Brazilian biomes, like the Atlantic forest, *cerrado*, Amazon rainforest and Brazilian northeast *caatinga* (Corrêa, 1984). In Brazil, there are eight species found: *E. mulungu*, *E. velutina*, *E. cista-galli*, *E. poeppigiana*, *E. fusca*, *E. falcata*, *E. speciosa* and *E. verna* (Lourenzi, 1992).

Phytochemical analysis has demonstrated the presence of terpenes in plants from the *Erythrina* genus (Serragiotto et al., 1981; Nkengfack et al., 1997), that are also recognized as bioactive alkaloid-rich plants (Ghosal et al., 1971; Barakat et al., 1977) and flavonoids, especially, isoflavones, pterocarpanes, flavanones and isoflavanones (Chacha et al., 2005). Some of these flavonoids have demonstrated a wide variety of biological activities (Table 2).

Studies have demonstrated the presence of analgesic and anti-inflammatory effects in extracts obtained from *E. senegalensis*, *E. velutina* and *E. mulungu* (Vasconcelos et al., 2003). In folk medicine, various species are utilized as a tranquilizer, against insomnia and to treat inflammation (Garcia-Mateos et al., 2001).

### 3.1 Bibliographic review

We conducted a literature review using the database SciFinder Scholar®, and from the results obtained, we prepared two tables of data showing the correlation between popular use and the plant part utilized, as well as the form of utilization (Table 1), and the biological activities of the extracts obtained from *Erythrina* species (Table 2). Due to the large amount of data for phytochemicals isolated from the *Erythrina* species, we organized them in a simplified table (Table 3).

Uses	Part Utilized	Kind of Extract/ Way of Use and Administration	Species	Locality	Reference
Trachoma Malaria Syphilis Elephantiasis	Bark Roots Roots Bark	Unspecified, oral Unspecified, oral Unspecified Unspecified, external	<i>Erythrina abyssinica</i>	Kenya	Ichimaru et al. (1996) Kamat et al. (1981) Moriyasu et al. (1998)
Colic	Roots	Decoction, oral	<i>Erythrina abyssinica</i>	Tanzania	Chhabra et al. (1984)
Syphilis	Flowers	Infusion, oral	<i>Erythrina abyssinica</i>	Uganda	Kamusiime et al. (1996)
Fever Leprosy  Dysentery Gonorrhoea Hepatitis	Leaves  Stalk Stalk	Unspecified, oral	<i>Erythrina abyssinica</i>	Rwanda	Chagnon (1984) Boily & Van Puyvelde (1986) Maikere-Faniyo et al. (1989) Vlietinck et al. (1995)
Schistosomiasis of the urinary tract	Unspecified	Decoction, oral	<i>Erythrina abyssinica</i>	Zimbabwe	Ndamba et al. (1994)
Poison antidote	Roots	Unspecified	<i>Erythrina abyssinica</i>	India	Selvanayahgam et al. (1994)
Anthelmintic	Green bark stem	Unspecified, oral	<i>Erythrina abyssinica</i>	East Africa	Kokwaro (1976)
Contraception Parturition Malaria Insomnia	Bark Bark Whole plant Flowers	Unspecified, oral Unspecified, oral Unspecified, oral Unspecified, oral	<i>Erythrina americana</i>	Mexico	Hastings (1990) Dominguez & Alcorn (1985)

Uses	Part Utilized	Kind of Extract/Way of Use and Administration	Species	Locality	Reference
Hypnotic Inflammation of the arms, legs, hair and eyes. Abscesses Insect bites Ulcers Curare-like effect	Flowers Fruits Leaves Leaves Leaves Seeds	Unspecified, oral Unspecified, External Unspecified, external Unspecified, oral Unspecified, external Unspecified, external			
Anthelmintic Earache	Bark Leaves	Decoction, oral Juice of leaves, aural	<i>Erythrina arborescens</i>	Nepal	Manandhar (1995) Bhattarai (1991)
Pork skin disease	Leaves	Unspecified, external	<i>Erythrina arborescens</i>	India	Rao (1981)
Snakebite Abscesses Boils Infections of skin and mucous Dermatitis and inflammation	Bark Leaves Leaves Leaves Leaves	Infusion, oral Unspecified, external Unspecified, external Unspecified, external Unspecified, external	<i>Erythrina berteroana</i>	Guatemala	Giron et al. (1991) Caceres et al. (1987)
Poison antidote	Bark	Infusion, oral	<i>Erythrina berteroana</i>	India	Selvanayahgam et al. (1994)
Fish poison Female diseases Sedative Bleeding Dysentery Poison Narcotic	Branches Whole plant Flowers Flowers Flowers Seeds Unspecified	Unspecified Unspecified, oral Decoction, oral Decoction, oral Decoction, oral Unspecified, oral Decoction, Unspecified	<i>Erythrina berteroana</i>	Mexico	Hastings (1990)
Sedative Bleeding Dysentery	Leaves and flowers Flowers Flowers	Infusion, oral Unspecified, oral Unspecified, oral	<i>Erythrina berteroana</i>	Central America	Morton (1994)
Female diseases	Unspecified	Unspecified, oral	<i>Erythrina berteroana</i>	Panama	Duke & Ayensu (1994)
Antiasthmatic Expel placenta	Bark Leaves	Unspecified Unspecified, oral	<i>Erythrina coralloidendron</i>	Antilles	Ayensu (1978)
Measles	Seeds	Unspecified, external	<i>Erythrina coralloides</i>	Mexico	Hastings (1990)

Uses	Part Utilized	Kind of Extract/Way of Use and Administration	Species	Locality	Reference
Urinary Tract Infection	Bark	Decoction, oral	<i>Erythrina crista-galli</i>	Argentina	Perez & Anesini (1994)
Respiratory Tract Infection	Bark	Decoction, oral			
Diarrhea	Leaves	Unspecified, external			
Anti-hemorrhoids	Stalk	Unspecified, oral			
Narcotic Antiseptic	Stalk	Unspecified, external			
Antimicrobial Throat infections	Stalk+leaves	Unspecified, external	<i>Erythrina crista-galli</i>	Brazil	Simões et al. (1999)
Astringent in wound healing	Stalk+leaves	Unspecified, oral			
Swelling	Stalk+leaves	Unspecified, external			
Healing	Bark	Suspension in water, oral	<i>Erythrina dominguezii</i>	Argentina	Filipoy (1994)
Diarrhea	Leaves	Infusion, oral	<i>Erythrina flabelliformis</i>	Mexico	Hastings (1990)
Toothache	Seeds	Unspecified, oral			
Erotic dreams	Seeds	Unspecified, oral			
Toxic	Seeds	Unspecified, oral			
Purgative Contraceptive	Seeds	Unspecified, oral			
Inflammation of uterus	Bark	Decoction, oral	<i>Erythrina folkersii</i>	Mexico	Zamora-Martinez & Pola (1992)
Appendicitis	Whole plant	Unspecified, oral			
Diuretic	Seeds	Unspecified			
Migraine	Bark	Infusion, external	<i>Erythrina fusca</i>	Peru	Duke (1994)
Infected wounds	Bark	Decoction, external			
Fungal dermatosis	Bark	Decoction, external			
Antitussive	Flowers	Decoction, oral			
Anti-inflammatory	Bark and leaves	Unspecified, oral	<i>Erythrina fusca</i>	Thailand	Wasuwat (1967)
Skin infections	Seeds	Unspecified	<i>Erythrina fusca</i>	Indonesia	Widianto (1980)
Itch	Seeds	Unspecified			
Headache	Bark and leaves	Infusion, oral	<i>Erythrina glauca</i>	Peru	Jovel et al. (1996)
Narcotic	leaves	Infusion, oral			
Kidney	Bark and	Infusion, oral			

Uses	Part Utilized	Kind of Extract/Way of Use and Administration	Species	Locality	Reference
inflammation Purgative Antimalarial	leaves Bark and leaves Bark and leaves Unspecified	Infusion, oral Decocction, oral			
Rats and dogs poison	Seeds	Unspecified, oral	<i>Erythrina herbacea</i>	Mexico	Hastings (1990)
Tuberculosis	Bark	Infusion, oral	<i>Erythrina humeana</i>	South Africa	Pillay et al. (2001)
Antipyretic Anthelmintic Astringent Expectorant Eye drops Antibilious Stomach upset Menstrual regulator Aphrodisiac Laxative Diuretic Stimulation of milk production	Bark Bark and leaves Bark Bark Bark Bark Bark+roots Leaves Leaves Leaves Leaves	Unspecified, oral Unspecified, oral Unspecified, external Unspecified, oral Unspecified, ophthalmic Unspecified, oral Juice, oral With milk, oral Unspecified, oral Unspecified, oral Unspecified, oral	<i>Erythrina indica</i>	India	Khan et al. (1994) John (1984) Chopra & Ghosh (1935) Pushpangadan & Atal (1984)
Poison	Whole plant	Unspecified	<i>Erythrina lanata</i>	Mexico	Hastings (1990)
Aphrodisiac	Bark	Unspecified, oral	<i>Erythrina mildbraedii</i>	Guinea	Vasileva (1969)
Antipyretic	Bark	Decoction, oral	<i>Erythrina mulungu</i>	Brazil	Brandão (1985)
Antimalarial	Leaves and roots	Decoction/infusion, oral	<i>Erythrina saclexii</i>	Tanzania	Gessler et al. (1995)
Postpartum (women) Treatment of female sterility	Bark Bark+leaves	Unspecified, oral Unspecified, oral	<i>Erythrina senegalensis</i>	Guinea	Vasileva (1969)
Serious injury Yellow fever Bronchial diseases Eye disorders Injuries	Bark Bark Bark Twigs and leaves	Unspecified, oral, external Unspecified, oral Unspecified, oral Unspecified, external	<i>Erythrina senegalensis</i>	Senegal	Le Grand & Wondergem (1987) Le Grand (1989)

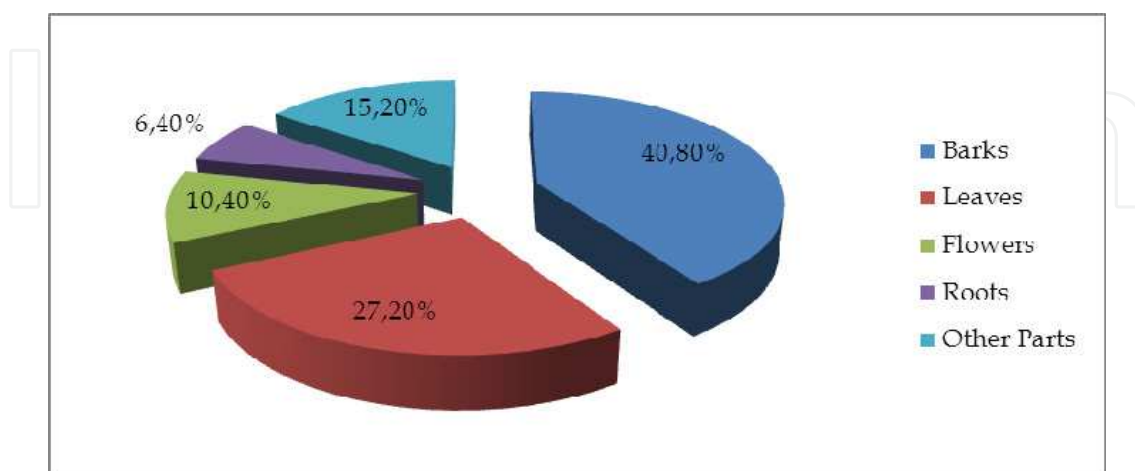
Uses	Part Utilized	Kind of Extract/Way of Use and Administration	Species	Locality	Reference
Ulcers Venereal diseases	Twigs and leaves Twigs and leaves	Unspecified, oral Unspecified, oral			
Antimalarial	Roots	Unspecified	<i>Erythrina senegalensis</i>	Nigeria	Etkin (1997)
Broken bones Antipyretic	Bark Leaves	Decoction, external Unspecified, oral	<i>Erythrina species</i>	Thailand	Anderson (1986) Mokkhasmit et al. (1971)
Analgesic	Leaves	Unspecified, oral	<i>Erythrina species</i>	Solomon Islands	Blackwood (1935)
Parturition induction Toothache Nosebleed	Bark and leaves Roots Roots	Infusion, oral Unspecified, oral Unspecified, external	<i>Erythrina standleyana</i>	Mexico	Hastings (1990) Dominguez & Alcorn (1985)
Epilepsy Leprosy	Bark Bark	Unspecified, oral Unspecified	<i>Erythrina stricta</i>	India	Chopra (1933)
Menorrhagia	Leaves	Unspecified, oral	<i>Erythrina subumbrans</i>	East Indias	Burkill (1966)
Antiseptic	Bark	Unspecified, external	<i>Erythrina ulei</i>	Peru	Desmarcheilier et al. (1997) Desmarcheilier et al. (1996)
Antiseptic	Stem Bark	Unspecified, external	<i>Erythrina ulei</i>	Argentina	Desmarcheilier et al. (1996)
Antipyretic	Bark	Decoction, oral	<i>Erythrina variegata</i>	Adaman Islands	Awasth (1991)
Epilepsy Stomach ache	Bark Bark	Unspecified, oral Juice, oral	<i>Erythrina variegata</i>	India	Pushpangadan & Atal (1984) John (1984)
Swelling	Bark	Unspecified, external	<i>Erythrina variegata</i>	New Guinea	Holdsworth (1984)
Amenorrhea Conception Dysmenorrhea	Bark Bark Bark	Infusion, oral Infusion, oral Infusion, oral	<i>Erythrina variegata</i>	Rotuma	Mc Clatchey (1996)
Antipyretic Sedative Antiasthmatic	Flowers Flowers Flowers	Unspecified, oral Unspecified, oral Unspecified, oral	<i>Erythrina variegata</i>	Brazil	Sarragiotto et al. (1981)
Induce menstruation	Leaves	Juice, oral	<i>Erythrina variegata</i>	India	Das (1955)

Table 1. Popular uses of *Erythrina* species



### 3.1.1 Ethnopharmacological data

Plants of the *Erythrina* genus are utilized for a wide array of human diseases (Table 1). With regards the parts of the plants that are utilized, the most used is the bark, being 40.8% of the total of citations, as shown in Graphic 1.



Graphic 1. Parts of the plants utilized in folk medicine.

### 3.1.2 Biological activity data

Analysis of the biological activity data (Table 2) shows the wide variety of biological activity of plants from the *Erythrina* genus, and shows too that most of this corroborates with popular knowledge and uses.

It is noteworthy to point out that most of these activities, mainly the antibacterial and analgesic properties, confirm the different popular applications of extracts obtained from plants of this genus. We would like also to draw attention to the fact that in the Brazilian market there is the availability of a phytotherapeutic product from *Erythrina mulungu* widely used for anxiolytic purposes and as a sedative, activities confirmed by popular knowledge, but that, to our knowledge, have not yet been confirmed in pharmacological tests, showing that, despite the wide array of available data related to plants of this genus, there is still a need for more research about some of them.

It is important to note that some of the activities shown in the biological tests were not cited in the ethnopharmacological studies, which indicates yet another importance for plants of the *Erythrina* genus, which have the potential to provide new compounds for the development of drugs for the treatment of diseases such as cancer, diabetes and hypertension.

### 3.1.3 Phytochemical data

The phytochemical data (Table 3) analysis allowed for the verification of a predominance of alkaloids and flavonoids in the *Erythrina* genus. It is important to note that alkaloids are recognized as markers for plants of this genus in addition to showing a wide array of biological activities, and being important candidates in the development of new drugs.

Species	Part of the Plant	Biological Activities	Location	Reference
<i>Erythrina abyssinica</i>	Bark Leaves Roots Roots Root Bark Root Bark	Mitogenic activity Cell Culture Molluscicidal ( <i>Biomphalaria pfeifferi</i> ) Anti-bacterial Anti-bacterial (Gram-positive species, <i>Escherichia coli</i> ) Anti-yeast ( <i>Saccharomyces cerevisiae</i> ) Antimalárico	Kenya	Tachibana et al (1993) Kloos et al (1987) Kamat et al. (1981) Taniguchi et al. (1978) Yenesew et al. (2003a)
<i>Erythrina abyssinica</i>	Bark	Anti-bacterial ( <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus subtilis</i> e <i>Staphylococcus aureus</i> )	Sudan	Omer et al. (1998)
<i>Erythrina abyssinica</i>	Leaves          Trunk	Uterine relaxing and stimulant Muscle Relaxing and stimulant Periferic muscle relaxing and stimulant Toxic effect in rats Antidiarrheal Anti-bacterial ( <i>Salmonella typhi</i> , <i>Shigella flexnerishigella dysenteriae</i> , <i>Shigella boyd</i> , <i>Shigella sonnei</i> ) Antiviral	Rwanda	Chagnon (1984) Maikere-faniyo et al. (1989) Vlietinck et al. (1995)
<i>Erythrina abyssinica</i>	Root bark	Anti-bacterial Anti-fungal	East Africa	Taniguchi & Kubo (1993)
<i>Erythrina addisoniae</i>	Stem Bark	Anti-inflammatory	Cameroon	Talla et al. (2003)
<i>Erythrina americana</i>	Bark	Plant germination inhibition Molluscicidal	Unspecified	Dominguez & Alcorn (1985)
<i>Erythrina americana</i>	Seeds	Central Nervous System depressor	Mexico	Garin-Aguilar et al. (2000)
<i>Erythrina arborescens</i>	Leaves Leaves, stem Stem Stem	Hypotensive Cytotoxic Antispasmodic Uterine stimulant	India	Dhar et al. (1968)
<i>Erythrina berteriana</i>	Leaves	Anti-yeast Anti-bacterial	Guatemala	Caceres et al. (1987)
<i>Erythrina</i>	Leaves+Twigs	Cytotoxic	Panamá	Chapuis et al.

Species	Part of the Plant	Biological Activities	Location	Reference
<i>berteroana</i>	Root bark	Anti-fungal		(1988) Maillard et al. (1987)
<i>Erythrina berteroana</i>	Stem	Pherormone	Puerto Rico	Keiser et al. (1975)
<i>Erythrina bidwillii hybrid</i>	Root bark	Anti-fungal Anti-bacterial Anticoagulant	Okinawa	Iinuma & Tanaka (1994) Iinuma et al. (1994)
<i>Erythrina brevipflora</i>	Leaves+stem	Cancer induction	USA	Caldwell & Brewer (1983)
<i>Erythrina caffra</i>	Bark, leaves	COX1 inhibitor Anti-bacterial	South Africa	Pillay et al. (2001)
<i>Erythrina corallo dendron</i>	Dry fruit + leaves + stem	Antiphagocytic	Greece	Yannitsaros (1996)
<i>Erythrina corallo dendron</i>	Seeds	Trypsin inhibition	Israel	Joubert & Sharon (1985)
<i>Erythrina coromandelianum</i>	Whole plant	Molluscicidal	Puerto Rico	Medina& Woodbury (1979)
<i>Erythrina crista-galli</i>	Aerial parts  Bark	Analgesic Anti-inflammatory Anti-bacterial Anti-fungal	Argentina	Mino et al. (2002) Perez & Anesini (1994)
<i>Erythrina crista-galli</i>	Flowers	Anti-mutagenic	Unspecified	Ishii et al. (1984)
<i>Erythrina crista-galli</i>	Fresh fruit + leaves + stem	Anti-phagocytic	Greece	Yannitsaros (1996)
<i>Erythrina crista-galli</i>	Leaves	Anti-fungal Anti-bacterial	Egypti	Ross et al. (1980)
<i>Erythrina crista-galli</i>	Leaves + stem	Cytotoxic Antiviral	Brazil	Simo es et al. (1999)
<i>Erythrina crista-galli</i>	Leaves + stem	Animal repellent	Germany	Wink (1984)
<i>Erythrina crista-galli</i>	Root and stem bark	Anti-bacterial Anti-mycobacterial	Bolivia	Mitscher et al. (1984) Mitscher et al. (1988)
<i>Erythrina crista-galli</i>	Seeds	Trypsin inhibition	Uruguay	Joubert & Sharon (1985)
<i>Erythrina eriotricha</i>	Root bark	Anti-bacterial	Cameroon	Nkengfack et al. (1995)
<i>Erythrina excelsa</i>	Root bark	Anti-bacterial/anti-fungal	East Africa	Taniguchi et al. (1993)
<i>Erythrina</i>	Seeds	Larvicidal	Unspecified	Janzen et al.

Species	Part of the Plant	Biological Activities	Location	Reference
<i>flabelliformis</i>				(1977)
<i>Erythrina fusca</i>	Leaves	Hypotensive Uterine stimulant Diuretic	Thailand	Unakul (1950)
<i>Erythrina fusca</i>	Seeds	Central Nervous System depressor	Indonesia	Widianto et al. (1980)
<i>Erythrina glauca</i>	Bark	Antiviral	Guatemala	Mc Kee et al. (1997)
<i>Erythrina humeana</i>	Bark, leaves	Anti-bacterial COX1 inhibitor	South Africa	Pillay et al. (2001)
<i>Erythrina indica</i>	Leaves	Anti-fungal Anti-bacterial	Egypt	Ross et al. (1980)
<i>Erythrina indica</i>	Leaves	Central Nervous System depressor	Sri Lanka	Ratnasooriya & Dharmasiri (1999)
<i>Erythrina indica</i>	Unspecified	Stimulant and inhibitor of lymphocyte blastogenesis	India	Singh & Chatterjee (1979)
<i>Erythrina indica</i>	Root bark Stem bark	Anti-mycobacterial Anti-bacterial Cytotoxic	Nigeria	Waffo et al. (2000) Nkengfack et al. (2001)
<i>Erythrina indica</i>	Seeds	Anti-fungal Anti-bacterial	Egypt	Ross et al. (1980)
<i>Erythrina indica</i>	Seeds	Immunosuppressor	India	Singh (1979)
<i>Erythrina latissima</i>	Bark, leaves	COX1 inhibitor Anti-bacterial	South Africa	Pillay et al. (2001)
<i>Erythrina lysistemon</i>	Bark, leaves	COX1 inhibitor Anti-bacterial Anti-yeast	South Africa	Pillay et al. (2001) Rabe & Van Staden (1997) Motsei et al. (2003)
<i>Erythrina lysistemon</i>	Root	Antiviral	Tanzania	Mc Kee et al. (1997)
<i>Erythrina lysistemon</i>	Stem bark	Estrogenic Bone formation stimulant Antidiabetic Rises seric LDL	Cameroon	Njamen et al. (2007)
<i>Erythrina mildbraedii</i>	Whole plant	Anti-tumoral Toxic effect Cytotoxic	Unspecified	Suffness et al (1988)
<i>Erythrina mildbraedii</i>	Root	Anti-mycobacterial Anti-bacterial	Nigeria	Mitscher et al. (1988)

Species	Part of the Plant	Biological Activities	Location	Reference
<i>Erythrina poeppigiana</i>	Unspecified	Cytotoxic	Colombia	De Cerain et al. (1996)
<i>Erythrina resupinata</i>	Roots	Fetal anti-implantation Anti-tumoral Uterine stimulant Abortive Toxicity evaluation	India	Aswal et al. (1984)
<i>Erythrina rubrinervia</i>	Twigs	“DNA linker” Cytotoxic	Unspecified	Pezzuto et al. (1991)
<i>Erythrina sacleuxii</i>	Leavess, root bark	Antimalarial Cytotoxic	Tanzania	Gessler et al. (1994) Gessler et al. (1995)
<i>Erythrina senegalensis</i>	Bark, root, stem bark  Flowers	Antimalarial Analgesic Anti-inflammatory Anti-bacterial Molluscicidal	Nigeria	Saidu et al. (2000) Etkin (1997) Ajaiyeoba et al. (2004) Hussain & Deeni (1991) Okunji & Iwu (1988)
<i>Erythrina senegalensis</i>	Bark	Anti-bacterial Anti-fungal	Senegal	Le Grand & Wondergem (1988)
<i>Erythrina senegalensis</i>	Raiz	Antiviral	Guinea-Bissau	Silva et al. (1997)
<i>Erythrina sigmoidea</i>	Bark Bark, root bark  Stem bark	Anti-yeast Anti-bacterial Anti-fungal Skeletal muscle relaxing Antispasmodic Spasmolytic	Cameroon	Biyiti et al. (1988) Nkengfack et al. (1994) Benedicta et al. (1993) Nkeh et al. (1996)
<i>Erythrina species</i>	Bark	Anti-bacterial	China	Gaw & Wang (1949)
<i>Erythrina species</i>	Leaves	Pherormone	Puerto Rico	Keiser et al. (1975)
<i>Erythrina species</i>	Leaves	Anti tumoral	Indonesia	Itokawa et al. (1990)
<i>Erythrina species</i>	Leaves	Antipyretic	Thailand	Mokkhasmit et al. (1971)
<i>Erythrina species</i>	Stem bark	Anti-leishmaniasis Anti-trypanosomiasis	Bolivia	Fournet et al. (1994)

Species	Part of the Plant	Biological Activities	Location	Reference
<i>Erythrina standleyana</i>	Bark	Molluscicidal Inhibition of plant germination	Unspecified	Dominguez & Alcorn (1985)
<i>Erythrina stricta</i>	Stem          Leaves	Spasmolytic Hypotermic Diuretic Anticonvulsant Analgesic Antiviral Anti-fungal Anti-yeast Anti-protozoan Toxicity evaluation Cytotoxic	India	Bhakuni et al. (1988) Dhar et al. (1968)
<i>Erythrina suberosa</i>	Leaves      Stem bark	Hypotensive Anti-spermatogenic Anti-androgen Anti-gonadotropin Anti tumoral Toxicity evaluation Hypoglycemic Cytotoxic Antispasmodic	India	Dhar et al. (1968)
<i>Erythrina suberosa</i>	Leaves, seed oil	Anti-bacterial Anti-fungal	Thailand	Silpasuwon (1979) Joshi et al. (1981)
<i>Erythrina subumbrans</i>	Aerial parts	Fetal anti-implantation Uterine stimulant Anti tumoral Abortive effect Toxicity evaluation	India	Aswal et al. (1984)
<i>Erythrina ulei</i>	Bark	Anti-crustacean "DNA linker" Antioxidant	Peru	Desmarcheilier et al. (1996) Desmarcheilier et al. (1997)
<i>Erythrina variegata</i>	Bark	Anti gastric ulcer	Japan	Muto et al. (1994)
<i>Erythrina variegata</i>	Bark, leaves  Seeds oil  Stem	Inhibition of plant germination and growing Anti-bacterial Anti-fungal Juvenile hormone activity	India	Chauhan et al. (1989) Bhale et al. (1979) Tripathi & Rizvi (1984) Prabhu & John (1975)

Species	Part of the Plant	Biological Activities	Location	Reference
<i>Erythrina variegata</i>	Bark Stem bark	Phospholipase A2 inhibitor Prostaglandin synthesis inhibitor Central Nervous System effects Spasmolytic	Samoa	Hegde et al. (1997) Dunstan et al. (1997) Cox et al. (1989)
<i>Erythrina variegata</i>	Flowers	Anti-yeast Anti-bacterial	Thailand	Avirutnant & Pongpan (1983)
<i>Erythrina variegata</i>	Fresh flowers	Anxiolytic	Brazil	Flausino et al. (2007)
<i>Erythrina variegata</i>	Leaves Unspecified	Anti-inflammatory Skeletal muscle relaxing Barbiturates potentiator	Vietnam	Nguyen et al. (1991) Nguyen et al. (1992)
<i>Erythrina variegata</i>	Roots	Inhibitor of glutamate-pyruvate-transaminase	Taiwan	Yanfg et al. (1987)
<i>Erythrina variegata</i> var. <i>orientalis</i>	Leaves  Roots  Stem bark	Antispasmodic Cytotoxic Toxicity evaluation Anti-yeast Anti-bacterial Anti-mycobacterial Cytotoxic Antispasmodic	India	Dhar et al. (1968) Telikepalli et al. (1990) Dhar et al. (1968)
<i>Erythrina variegata</i> var. <i>orientalis</i>	Leaves	Anti tumoral	Philippines	Masilungan et al. (1971)
<i>Erythrina velutina</i>	Leaves  Stem bark Trunk bark	Analgesic Anti-inflammatory Uterine stimulant Molluscicidal	Brazil	Marchioro et al. (2005) Barros et al. (1970) Pinheiro de Sousa & Rouquayrol (1974)
<i>Erythrina vespertilio</i>	Bark	Inhibition of platelet aggregation Serotonin release inhibition	Australia	Rogers et al. (2001)
<i>Erythrina vogelii</i>	Root bark	Anti-fungal	Ivory Coast	Queiroz et al. (2002)
<i>Erythrina zeyheri</i>	Leaves	Anti-bacterial COX1 Inhibitor	South Africa	Pillay et al. (2001)

Table 2. Biological activity of *Erythrina* extracts.

Classes of Compounds	Occurrence	Percentage
Alkaloids	461	41.57
Coumarins	1	0.09
Steroids	29	2.62
Flavonoids	330	29.76
Lipids	32	2.88
Proteins	112	10.10
Triterpenes	31	2.80
Other compounds	113	10.19
Total	1109	100

Table 3. Occurrence of the different classes of compounds in the *Erythrina* genus

Some important alkaloids that are distributed within plants from the *Erythrina* genus are erytharbine, erythartine, erysotramidine and erysotrine, shown in figure 1. It is noteworthy that a characteristic feature of these alkaloids is the spiro structure in the rings bearing the nitrogen atom.

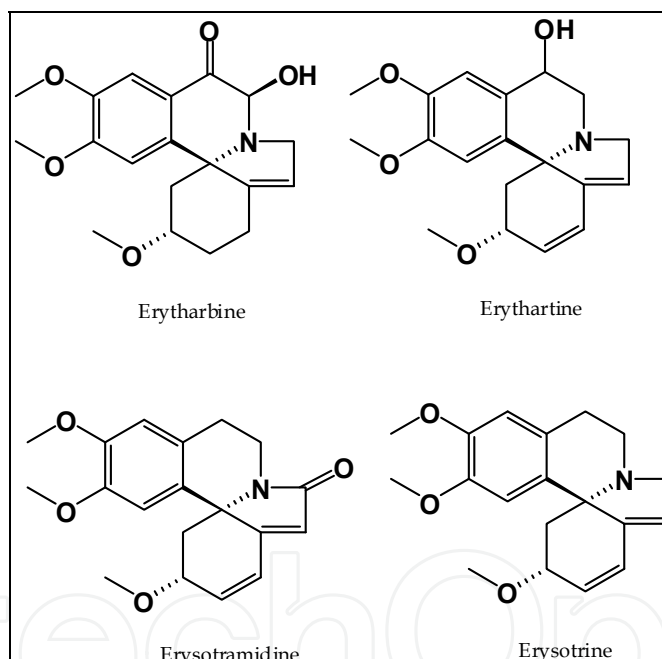


Fig. 1. Common alkaloids found in the *Erythrina* genus.

#### 4. Conclusion

This review showed that *Erythrina* species are commonly utilized for numerous diseases and that many ethnopharmacological studies have been performed in order to confirm the activities attributed to these species. Moreover, several classes of substances have been isolated from the *Erythrina* genus, mainly alkaloids (41.57%) and flavonoids (29.76%).

Despite the large amount of available data, some of the plants of this genus remain to be studied. An example is *Erythrina mulungu*, largely used in Brazil, yet a significant number of studies regarding its pharmacological properties and chemical composition were unable to



be found. A recent contribution to the knowledge about this plant is given by our group, regarding the anti-inflammatory and antinociceptive activities of a hydroalcoholic extract obtained from *E. mulungu* (Oliveira et al., *in press*).

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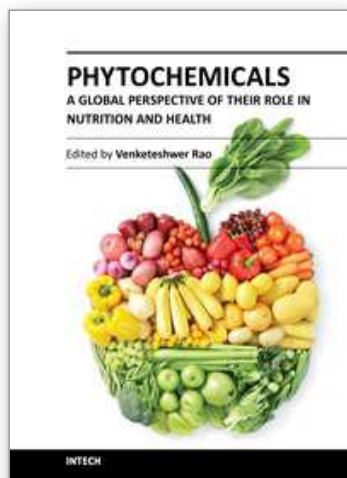
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