Assessing Sub-saharan Erythrina for Efficacy: Traditional uses, Biological Activities and Phytochemistry

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Abstract: The genus Erythrina comprises more than 100 species, widely distributed in tropical and subtropical areas. In Africa, 31 wild species and 14 cultivated species have been described. In sub-Saharan Africa, Erythrina species are used to treat frequent parasitic and microbial diseases, inflammation, cancer, wounds. The rationale of these traditional uses in African traditional medicine was established by screening several species for biological activities. Promising activities were found against bacteria, parasites (Plasmodium), human and phytopathogenic fungi, some of which were multiregion resistant (MDR) microorganisms. Some species also exhibited antioxidant, anti-inflammatory activities and enzymes inhibitory properties. Most of the species chemically investigated were reported to contain flavonoids, prenylated isoflavones, isoflavanones and pterocarps. Some phytochemicals (vogelin B, vogelin C, isowightone, abyssinian II, derrone) were the active principles as antibacterials, antifungals, antiparasitics and inhibitors of enzyme borne diseases (PTP1B, HIV protease, DGAT). This review highlights the important role of Erythrina species as sources of lead compounds or new class of phytotherapeutic agents for fighting against major public health (MDR infections, cancer, diabetes, obesity) in Sub-Saharan Africa.

Key words: Erythrina, bioactive compounds, infectious diseases, metabolic diseases, Sub-saharan Africa

INTRODUCTION

Among the potential uses of African plants, those used in traditional medicine are in the forefront (Sofowora, 2002). Herbal medicines are an important part of the culture and traditions of African people (Fennell et al., 2004). Many patients from resource poor settings have strong beliefs in the use and efficacy of ethnomedicines (Chinsembu and Hedimbi, 2010) on which they are reliant for their health care needs. Nowadays industrial companies incorporated ingredients from plant origin in their medicines (El-Said and Al-Barak, 2011). Approximately, between 70-78% of commercial pharmaceuticals included plants (Lokhande et al., 2007; Ikpeme et al., 2011).

According to Gupta and Sharma (2010), renewed interest in traditional pharmacopoeias has meant that researchers are concerned both with biological activities and phytopharmaceuticals of medicinal plants. Plants form a great part of the biodiversity in tropical areas such as Africa. Among the species of Africa’s flora, Erythrina species were considered.

The genus Erythrina (Leguminosae) is widely distributed in tropical and subtropical areas of the world (Silva et al., 2011). As most of Leguminosae, Erythrina species produce many secondary metabolites, some of which have a function of defense systems against pathogenic fungi and bacteria (Karthishwaran et al., 2010). Ethnobotanical discovery process of sub-Saharan Erythrina have resulted in promising biological activities (Kone et al., 2004; Nguyen et al., 2010). Their related bioactive compounds also were reported (Atindekou et al., 2002a; Sato et al., 2003; Na et al., 2007; Inmok et al., 2009). Many Erythrina species showed real potential for fighting against pathogenic agents incriminated in alarming public health problems in sub-Saharan Africa. For example, multiregion resistant pathogens are responsible for therapeutic failures (Kone and Kamanz Atindehou, 2009). This situation is serious because microbial infections are the most frequent opportunistic diseases occurring during HIV/aids which affected many people in Africa. Moreover, during this infection, cancer and cardiovascular diseases, oxidative stress, generating free radicals, is recognized to cause damage in cells and immune system of patients. Scientists are searching for new molecules that can be alternative to conventional treatments (Coulidiati et al., 2011).

This present review aimed at assessing the ethnomedical, biological and phytochemical properties of several sub-Saharan Erythrina species studied in our
laboratory and other laboratories from Africa, Asia, Europe and America. Studies are continuing on sub-Saharan Erythrina for identifying new biological activities or bioactive molecules. This review is limited to the only studies available from 1990 through to mid-2011.

**Botanical data:** Erythrina is pantropical, consisting of some 112 species, 70 neotropical, 31 African and 12 Asian. The genus is probably of South American origin but the ability of seeds to environments inhabited by the ancestral species has resulted in worldwide distribution (Kass, 1998). Erythrina species are trees, shrubs and perennial herbs with trifoliate leaves. Detailed botanical characteristics of these plants are described in many documents (Hutchinson and Dalziel, 1954-1972; Ake Assi, 2001).

Large cuttings and seeds can be used to reproduce Erythrina. This is an advantage whether a large scale use would be needed for development of medicines.

**Ethnomedicine: uses in traditional medicine:** Methods most often used to study tropical medicinal plant are random screening, taxonomic collecting or ethnobotanical collecting (Flasser, 1996). It has been shown that bioactive compounds from medicinal plants are of huge interest for drug development (Balick, 1990; Anago et al., 2011).

Although, species vary with region, Erythrina species are used as healing agents in traditional medicine in Africa. Of 31 African species, 11 (35%) have ethnomedical uses in sub-Saharan Africa. These are *E. abyssinica*, *E. addisoniae* Harms, *E. excelsa* Bak., *E. fusca* Lou., *E. latissima* E. Mey., *E. milbraedi* Harms, *E. poepiggiana* (Walp.) O.F. Cook, *E. senegalensis* A. DC., *E. sigmoidea* Hu., *E. variegata* L. and *E. vogelii* Hook f. Other species may be used for health care, but no literature was available. Most of the consulted documents are articles obtained via Internet, Prelude Medicinal plants database (2008). This somewhat restricted the field of investigations, some documents such as thesis or reports not being accessible.

Erythrina species are widely prescribed in sub-Saharan traditional medicine against frequent diseases from microbial and parasitic origin. According to Prelude Medicinal Plants Database, *E. senegalensis* in West Africa and *E. abyssinica* in central Africa are the most used species. Thirty nine medicinal usages were found for *E. senegalensis* and 60 for *E. abyssinica*. *E. senegalensis* is used in West African countries for almost same therapeutic indications: Benin (Adjouhnoun et al., 1989), Cameroon (Atsam et al., 2011), Cote d'Ivoire (Trab, 1997), Camaruni Atindehou, 2002; Kone et al., 2004), Guinea (Magassouba et al., 2007), Guinea Bissau (Diniz et al., 1996), Mali (Togola et al., 2005, 2008) and Nigeria (Ainsie, 1937; MacDonald and Olorunfemi, 2000; Saidu et al., 2000; Igiol et al., 2005; Adamu et al., 2005). In Central Africa, *E. abyssinica* is used in Angola (Bosass, 1996), Burundi (Polygenis-Bigerdako, 1990), Ethiopia (Bekalo et al., 2009), Kenya (Njorge and Bussmann, 2006; Njorge and Kibunga, 2007; Wagate et al., 2010), Democratic Republic of Congo (Ayobangira et al., 2000), Rwanda (Van Puyvelde et al., 1997) and Uganda (Tabori et al., 2003; Lamorde et al., 2010). Also the use of this species in Nigeria was reported (Adamu et al., 2005). More information is available on Prehude and Pharmel databases.

The ailments treated are bacterial, fungal, parasitic and viral diseases, gastrointestinal disorders, liver disorders, sexual asthenia, nervous disorders, sterility, eyes diseases and kidney pain.

*E. abyssinica* and *E. senegalensis* also are prescribed in ethnoveterinary medicine practices against brucellosis, oedema, hygroma, dyspy, bacterial infections, skin diseases (Byavu et al., 2000; Ejobi et al., 2007).

Little information was found about the remaining species. *E. vogelii* is used in Cote d'Ivoire (Atindehou et al., 2002a) and Cameroon (Ali et al., 2010) against microbial infections. *E. sigmoidea* is prescribed against inflammations (Njamen et al., 2004; Kouam et al., 2007; Udum et al., 2010) and cancer (Watjen et al., 2007). *E. milbraeidi* is used to prepare remedies against prostate (Teohoukouha et al., 2010).

No therapeutic uses were found in sub-Saharan Africa for the introduced species such as *E. poepiggiana* and *E. fusca*. In other countries, these plants are used against microbial infections (Sato et al., 2003), fever and inflammations (Innok et al., 2009).

All plant parts (leaves, stem barks, roots and flowers) are used for the preparation of remedies in the form of decoction, maceration, infusion, powders or calcinates to treat diseases. The treatments are administered by oral routes and baths.

**Biological activities: rational uses of sub-Saharan Erythrina in traditional medicine:** The sub-Saharan *Erythrina* species have been screened for their biological activities against various bacteria, fungi, parasites, enzymes borne diseases and free radicals.

**Antibacterial activity:** Sanitation and hygiene levels for the majority of people in Africa are not comparable to those of First World countries. Consequently African people are threatened by bacterial infections (Fennell et al., 2004) which are of public health concern.
Multidrug-resistant (MDR) bacteria have been reported in sub-Saharan Africa (Aka et al., 1987; Okesola et al., 1999; Benbachir et al., 2001; Kacou-N’Dour et al., 2001; Akour-Koffi et al., 2004; Akinremi et al., 2005). Besides this resistance, commercial antibacterial agents are incriminated for their numerous side effects (Nebedum et al., 2009). Medicinal plants such as *Erythrina* species are often used to treat bacterial infections.

Antibacterial tests were carried out using various screening methods such as agar diffusion, dilution and microdilution methods (Kone et al., 2004). The plant extracts were prepared from one solvent (ethanol, methanol, dichloromethane and acetone) or successively extracted with solvents from different polarity. The studied bacteria were positive gram and negative gram strains some of which were MDR-bacteria (MRSA). They were collection and clinical strains of *Bacillus cereus*, *Escherichia coli*, *Micrococcus lutea*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Proteus mirabilis*, *Enterococcus faecalis*, *Streptococcus sp.*, *Pseudomonas aeruginosa* and *Lactobacillus* sp.

The results of all antibacterial screening showed high sensitivity of positive gram bacteria to *Erythrina* species extracts (Wagata et al., 2010). The susceptibility of gram-positive bacteria to extracts can be attributed to the fact that the cell wall of these bacteria is easier to penetrate than that of gram-negative bacteria (Rang and Dale, 1987).

*E. senegalensis* (Kone et al., 2004; Kone et al., 2007; Soro et al., 2010) and *E. vogelii* (Atindehou et al., 2002b) showed strong anti-MRSA activity (MICs = 12-3 μg mL⁻¹).

Against *Pseudomonas aeruginosa* and *Staphylococcus epidermidis*, a moderate antibacterial activity (375-94 μg mL⁻¹) was observed. *E. poepigiana* exhibited antibacterial activity against bacteria such as MRSA (Sato et al., 2003, 2006). According to Fomum et al. (1983) *E. signoides* possesses antibacterial activity. *E. variegata* showed activity against MRSA, *Streptococcus mutans* and *Lactobacillus* sp. (Tanaka et al., 2002; Sato et al., 2004).

None of sub-Saharan *Erythrina* species was reported to show activity against *Escherichia coli*.

The antibacterial activity gave evidence to the traditional uses of some African *Erythrina* species in traditional medicine against bacterial infections. Interestingly all sub-Saharan *Erythrina* have a high antibacterial activity, in particular against MDR-bacteria (MRSA, MLS). *Erythrina* species with anti-multidrug-resistance activity are promising and could be used for fighting against MDR-bacterial infections in sub-Saharan Africa.

**Antifungal activity:** Infections caused by *Candida albicans* (Sunday-Adeoye et al., 2009) are of importance because HIV/AIDS infection is devastating epidemic in Africa (Fennell et al., 2004). They are the earliest opportunistic affections during this disease. *Erythrina* species are used in sub-Saharan Africa for treating mycological diseases and some have been screened for antifungal activity. The potency of ethanol, methanol and dichloromethane extracts from these plants was evaluated against fungi and yeasts, using the bioautography (Homans and Fuchs, 1970) and agar overlay (Rahalison et al., 1991) methods on thin layer chromatograms. The most active extracts were non-polar ones (dichloromethane). This gives an indication on the lipophilic nature of the active compounds. *E. senegalensis* (Soro et al., 2010) and *E. poepigiana* were active against *C. albicans*. *E. vogelii* exhibited activity against *Cladosporium cucumerinum*, a phytopathogenic filamentous fungus, while *E. variegata* was active against *Actinomyces* sp. (Sato et al., 2003).

**Antiplasmodial activity:** Malaria is part of the serious diseases and mortalities in the tropical areas, in particular in Africa. In sub-Saharan Africa, this infectious disease, causing enormous deaths, is endemic due to warm climate (Dadi et al., 2011). It is recognized today that malaria is responsible for poverty and a major hurdle with economic development in many countries where this disease prevails. Treatments are available and still effective for the time being. However, there is an urgent need to search for new sources of drugs because the disease-borne agent, *Plasmodium* develops quickly resistance to the molecules in use (Peters, 1998; Wellems and Plowe, 2001; Djama et al., 2004; Pradines et al., 2010).

The antiplasmodial activity was evaluated using ³H-hypoxanthine and lactate dehydrogenase methods. Data on antiplasmodial activity were found only for *E. senegalensis* and *E. fuscias.* The aqueous extract of *E. senegalensis* stem bark showed a weak activity against *Plasmodium berghei* (Saidu et al., 2000). The roots ethanolic extract exhibited strong activity against a multiresistant strain K1 of *Plasmodium falciparum*, with an IC₅₀ of 1.82 μg mL⁻¹ (Atindehou et al., 2004) while the methanol extract inhibited the growth of the same strain (IC₅₀ = 99.7 μg mL⁻¹). *E. abyssinica* stem bark (ethyl acetate) exhibited activity against chloroquine-sensitive (D6) and -resistant (W2) *P. falciparum*, with IC₅₀ values of 7.9±1.1 and 5.3±0.7 μg mL⁻¹, respectively (Yenesew et al., 2004). The stem bark ethyl acetate extract of *E. fuscias* showed antimalarial activity against the multidrug resistant K1 strain of *P. falciparum* (Khoaem et al., 2008; Inoue et al., 2009).
**Anti-cancer, antioxidant and anti-inflammatory activities:**

High incidence of cancer, inflammations, cardiovascular diseases is attributed to the oxidative stress. Some sub-Saharan *Erythrina* species are used by traditional practitioners to treat cancer and inflammations. These plants were investigated for cancer chemopreventive agents and inhibitors of enzymes-borne diseases. The studies were carried out on enzymes such as phospholipase C gamma1, diacylglycerol acyltransferase (DGAT), protein tyrosine phosphatase 1 B (PTP1B), ERK kinase, 5-lipoxygenase and 15-lipoxygenase. Inhibitors of these enzymes are proposed in therapy of obesity, type 2 diabetes and cancer. The methods used are MTT method, Lewis lung cancer mice model, G-quadruplex system stability experiment.

Ethyl acetate extract of *E. milbraedii* stem bark inhibited PTP1B (Na et al., 2007; Jang et al., 2008). Dichloromethane extract of *E. senegalensis* stem barks gave inhibitory action against DGAT (Oh et al., 2009).

*E. addisoniae* acts by decreasing the ERK kinase activation (Watjen et al., 2007). The ethyl acetate extract inhibited PTP1B (Bae et al., 2006). *E. variegata* showed in vitro and in vivo anti-tumor activity against various tumor cells of the liver and lung (Zhang et al., 2009). A dose-response effect was observed. *E. milbraedii* was tested for effects on the growth of human breast and prostate (Tehokouihara et al., 2010).

*Erythrina* species were tested for efficacy in reducing pain and inflammation using mouse paw edema test, 5-lipoxygenase pathway. *E. sigmoidea* (Njamen et al., 2004), *E. senegalensis* (Udem et al., 2010) and *E. addisoniae* (Talla et al., 2003) showed anti-inflammatory activity.

*E. mildbraedii* ethyl acetate extract showed anti-inflammatory activity and radical scavenging activity in 1, 1-Diphenyl-2-Picrylhydrazyl (DPPH) assay (Njamen et al., 2004).

*E. senegalensis* (Soro et al., 2010) also exhibited the same potential. *E. variegata* extracts (aqueous, methanol) were DPPH and nitric oxide radical scavengers and inhibitors of lipid peroxidation (Sakat and Juvekar, 2010).

The antitumor, antioxidant and anti-inflammatory activities confirm the traditional use of several species of *Erythrina* in the treatment of cancer, prostate and inflammation.

**Anti-viral activity:**

The possible antiviral activity was evaluated vs viral enzymes such as proteases and neuraminidases. Protease is linked to HIV while neuraminidases are related to Influenza. Inhibitors of viral neuraminidase played an important role in the treatment of influenza. *E. senegalensis* showed inhibitory activity on HIV-1 protease (Lee et al., 2009), thus letting foresee a prospect in research for treatment against HIV/AIDS infection. The roots ethyl acetate extract of *E. addisoniae* exhibited an antiviral activity against H1N1 and H9N2 neuraminidases (Nguyen et al., 2010).

**Other biological activities:**

*E. senegalensis* possesses analgesic and antipyretic action (Sadou et al., 2000) which supports its use in preparation of traditional remedies against malaria. *E. variegata* leaf showed anti-diabetic potential by reducing glycoemic induced in rat (Kumar et al., 2011).

**Bioactive compounds isolated from sub-Saharan Erythrina:**

The genus *Erythrina* is particularly known for its typical alkaloids some of which have an action similar to that of curare (Kamanzi Atindehou, 2002). A review of alkaloids from 1996 through to mid-2009 was recently carried out by (Parsons and Falmam, 2010). The flavonoids also are well represented within the genus; the great majority is flavonones, isoflavones, coumestans and pterocarps (Dewick, 1993; Barron and Ibrahim, 1996). The present review on bioactive compounds of sub-Saharan *Erythrina* is devoted to non alkaloidal secondary metabolites recently identified as antibacterial, antifungal, inhibitory, anti-inflammatory active principles.

**Compounds isolated from sub-Saharan Erythrina:**

The conventional methods of chromatography were used to isolate molecules from sub-Saharan *Erythrina*. Their structures were elucidated on the basis of spectroscopic (UV, CD, MS, 1D and 2D NMR) and physicochemical analyses. Some of these structures are shown in Fig. 1. The majority of studied sub-Saharan *Erythrina* were carried out in laboratories from Europe, Asia and America due to lack of adapted equipment in many laboratories from sub-Saharan Africa. The African teams actively getting involved in research on sub-Saharan *Erythrina* phytchemistry, in collaboration with external teams, are those of Cameroun (Wandji et al., 1994; Nkengfack et al., 2001; Waffo et al., 2000; Waffo et al., 2006). Common and known compounds (isouligene, isouligubigene, 1-methoxyphaelsoellidine, ulexine, warangalone, lomchoapoals, wighteone, dolichines, sobavachalcone, erythrabissine, phaseollidine) have been isolated from sub-Saharan *Erythrina* species (Tayler et al., 1986; Mitscher et al., 1998; Wandji et al., 1990; Telikepalli et al., 1990; Dagne et al., 1993; Dewick, 1993; Wandji et al., 1994; Barron and Ibrahim, 1996; Tanaka et al., 1996; Huang and Liu, 1997; Joubert, 1998; Oh et al., 1999; Yu et al., 2000; Wanzala and Majinda, 2000a, b; Tanaka et al., 2001;
Fig. 1: Structures of molecules isolated from *Erythrina* species

Wanjala and Majinda, 2001; Nkengfack et al., 2001; Tanaka et al., 2002; Atindepou et al., 2002a; Queiroz et al., 2002; Sato et al., 2003; Khaomek et al., 2008; Lee et al., 2009). In addition to these compounds, specific products to each studied species were described for the first at the time of their isolation. They are vogelins (Atindepou et al., 2002a; Queiroz et al., 2002; Waffo et al., 2006; Ali et al., 2010), senegalensis (Fomum et al., 1986; Wandji et al., 1990; Wandji et al., 1994, Tanaka et al., 2001), erysenegalensisins (Wandji et al., 1990, 1994, Wandji et al., 1995; Oh et al., 1999), fuscaflavanones (Innok et al., 2009), sigmoidins (Promsatha et al., 1988; Nkengfack et al., 1993, 1994a, b, 1997; Njamen et al., 2004; Ali et al., 2011), indicaines and indicacins (Waffo et al., 2000; Nkengfack et al., 2000).

**Biologically active compounds:** Some of the compounds (Table 1) isolated from sub-Saharan *Erythrina* species have been screened for biological activity against various pathogenic micro-organisms.
Table 1: Phytochemicals isolated from Subsaharian *Erythrina* species

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Organs used</th>
<th>Compounds</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td><em>Erythrina addisoniae</em> Harms</td>
<td>Stem bark</td>
<td>Fuscaflavanone A1, A2, B, lupinofolin, lonicarpol A, lonicarpols C1, C2, D1 et D2, sandwichisin, plusulosidin, erythabiosin I, dolichin A et B, isovitexinone, vitexone</td>
<td>Jurek et al. (2009)</td>
</tr>
<tr>
<td><em>Erythrina fusca</em> Lour.</td>
<td>Stem bark</td>
<td>Isolupioligogenous, inositol, leucocyanidins</td>
<td>Fornum et al. (1986), Nkengfack et al. (2000), 2001 and Waffo et al. (2000)</td>
</tr>
<tr>
<td><em>Erythrina indica</em> Linn.</td>
<td>Stem bark</td>
<td>Pterocarpans</td>
<td>Mitcher et al. (1998)</td>
</tr>
<tr>
<td><em>Erythrina millefoliata</em> Harms</td>
<td>Stem bark</td>
<td>Pterocarpan</td>
<td>Sato et al. (2003)</td>
</tr>
<tr>
<td><em>Erythrina poepigigiana</em> (Wulff.)</td>
<td>Roots</td>
<td>Erycogenin A, demethylenedicarpin, sandwichisin, argentol, eropostyrene</td>
<td>Taylor et al. (1986), Wandji et al. (1990), Oh et al. (1999), Fornum et al. (1986) and Wandji et al. (1990, 1994, 1995)</td>
</tr>
<tr>
<td><em>Erythrina senegalensis</em> DC.</td>
<td>Stem bark</td>
<td>2,3-dihydropirroline, 6,8-diprenylgenistein, senepolgenin, n-triacetyltricocantine, erythrinaflavone, erythralanegenin N, O, erythralanegenine D, F, G, L et M, 8-prenylflavone, auriculatin, derrose, alpinominovanone</td>
<td>Taylor et al. (1986), Wandji et al. (1990), Oh et al. (1999), Fornum et al. (1986) and Wandji et al. (1990, 1994, 1995)</td>
</tr>
<tr>
<td><em>Erythrina sigmoidea</em> Hua</td>
<td>Stem bark</td>
<td>Sigmodin A, sigmodin B, sigmodin E, sigmodin F, sigmodin G, sigmodin L, sigmodin K</td>
<td>Fornum et al. (1983), Njamen et al. (2004), Nkengfack et al. (1994a, b), Nkengfack et al. (1997) and Promatuna et al. (1988)</td>
</tr>
<tr>
<td></td>
<td>Stem bark</td>
<td>6,8-diprenylgenistein, 8-prenylflavone, waragalone (scandeloni), limonosin, caraphenone</td>
<td>Waffo et al. (2006)</td>
</tr>
</tbody>
</table>

NI = Non indicated; bold type = Compounds with known biological activities

**Against bacteria:** Erycogenin A, demethylenedicarpin, sandwichisin, argentol, eropostyrene (Sato et al., 2003), isolupioligogenous and erythrinin B (Sato et al., 2006) isolated from *E. poepigigiana*, have strong activity against MDR-bacteria (MRSA) with MICs ranging between 1.56-3.13 μg mL⁻¹. Also, isovitexinone, vogelin B, vogelin C and the 1-methoxyphaseoldin from *E. vogelli* showed high potential against MRSA, with MICs = 1.6-3.125 μg mL⁻¹ (Kamanzi Atindehou, 2002). The sigmodins (*E. sigmoidea*) showed antibacterial activity (Fornum et al., 1983). Erycristagallin and orientanol B ( *E. variegata*) showed high anti-MRSA activity, with MICs of 3.13-6.25 μg mL⁻¹ (Tanaka et al., 2002).

Most of these antibacterial molecules have phenolic hydroxyls and prenylated groups. According to Barron and Ibrahim (1996), antibacterial and antifungal activities of flavonoids are mainly attributed to the presence of phenolic hydroxyls, since they act like inhibitors of enzymes. Also, the substitution of flavonic ring by prenylated groups, render these substances lipophilic and induces antimicrobial activity through membrane interactions of the involved cells.

**Against fungi and yeasts:** Eryopostyrene (*E. poepigigiana*) was responsible for antifungal activity against *Candida albicans*, with MIC = 50 μg mL⁻¹ (Sato et al., 2003). Isovitexinone and 1-methoxyphaseolidin showed high antifungal activity against *Caldosporium cucumerinum* (Kamanzi Atindehou, 2002).

**Against Plasmodium falciparum:** Phaseolidin (*E. fusca*) exhibited moderate antiplasmodial activity against *Plasmodium falciparum* (Innok et al., 2006) while lonicarpol A showed strong antimalarial activity, with IC₅₀ value of 1.6 μg mL⁻¹ (Khaomlek et al., 2008). From ethyl acetate extract of *E. abyssinica*, 5-prenylbutein and 5-deoxyabysin in II have been isolated as antiplasmodial principles (Yenesew et al., 2004).

**Cytotoxicity activity:** In addition to phaseolidin and lonicarpol A, lupinofolin, sobavachalcone and fuscaflavanone showed weak to moderate cytotoxic activity against KB, BC and NCI-H187 cells (Innok et al., 2009).

**Anti-inflammatory and antioxidant activity:** Sigmoidins were responsible for anti-inflammatory and antioxidant activities of *E. sigmoidea* (Njamen et al., 2004). Waragalone (*E. addisonia*) showed marked effectiveness as an anti-inflammatory after systemic and local administration, respectively (Talal et al., 2003). *In vitro*, erycristagallin (*E. milbraedii*) inhibited the arachidonic acid metabolism via 5-lipoxygenase pathway in rat polymorphonuclear leukocytes (IC₅₀ = 23.4 μM) but had no effect on cyclooxygenase-1 metabolism in human platelets. This compound showed antioxidant activity in DPPH test (Njamen et al., 2003).

**Inhibitors of enzymes borne diseases:** 8-prenylflavone, auriculatin, erysengaleniens and alpinuminovavone of
E. senegalensis showed dose-dependent inhibitory activity on HIV-1 protease (IC\textsubscript{50} = 0.5 to 30 mM) (Lee et al., 2009). According to the same author, this inhibitory activity could be due to the presence of hydroxyl groups (nouan B) and prenylated groups (nouan A) in the structure of active molecules. Pteroarpenans from E. senegalensis were strong inhibitors of 15-lipoxygenase (Togola et al., 2009).

For Erythrina addictionae, it was observed that stilbenoids and chalcones were more active than isoflavones on neuraminidases. Stilbenoid gave high inhibitory effects on H1N1 (IC\textsubscript{50} = 8.80±0.34 µg mL\textsuperscript{-1}) and H9N2 (IC\textsubscript{50} = 7.19±0.40 µg mL\textsuperscript{-1}) neuraminidases (Nguyen et al., 2010).

Many molecules such as 2-arylbenzofurans, Orientanol E, 2,3-dihydroauriculatin, isolated from sub-Saharan Erythrina can be considered as new anticancer materials by PTP1B inhibition. Three structural conditions are important to inhibit the enzyme: B ring prenyl groups, hydroxylation (C-2'-and C-4') and cyclization between C-7 hydroxy group (B-ring) and C-6 or C-8 prenyl groups (A-ring) (Bae et al., 2006; Na et al., 2007). Orientanol E, 2,3-dihydroauriculatin, 2-arylbenzofurans (E. addictionae) inhibited PTP1B (IC\textsubscript{50} = 2.6±0.5 to 17.5±0.3 µM). Abyssinum II and parvisflavone B (Jang et al., 2008), abyssinones, sigmoidin E and alpinumisoflavone (Na et al., 2007) from E. milbraedii also had effects (IC\textsubscript{50} = 5.3 to 42.6 µM).

Flavanones with dihydrofuran moiety from the same plant inhibited PTP1B activity in an in vitro assay with IC\textsubscript{50} values ranging from 15.2±1.2 to 19.6±2.3 µM (Cui et al., 2010).

E. senegalensis phytochemicals, namely 8-prenyletroene, auriculatin, erysenegalensis alpinumisoflavone and 6,8-diprenylgenistein inhibited DGAT activity (IC\textsubscript{50} = 1.1±0.3 to 15.1±1.1 µg mL\textsuperscript{-1}). On the basis of these data, isoflavonoids with isoprenyl groups could be considered as a novel class of DGAT inhibitors (Oh et al., 2009).

Cytotoxicity activity was reported for E. milbraedii phytochemicals. Scandenone, 5,4-dihydroxy-2-methoxy-8-(3,3-dimethylallyl)-2",2"-dimethylpyrano[5,6,7] isoflavone and eryvin B strongly inhibited the growth of cell lines. For this cytotoxic activity, non-oxidized isoprenyl group at C-8 is an important structural condition (Tchokoua and et al., 2010). Phaseollin and neerunenol (E. addictionae) may be the active molecules (Watjen et al., 2007).

CONCLUSIONS

This review on sub-Saharan Erythrina clearly highlights their real potential for the treatment of infections from bacterial and fungal origin and malaria. Some among these plants and related phytochemicals (Isowightone and 1-methoxyphaseollidin) showed a high promising activity on multidrug resistant pathogens such as MRSA, Candida albicans and Plasmodium falciparum. This activities show the interest of genus Erythrina for fighting against public health problems in West Africa. Its natural bioactive substances could be a prospect in the development for new therapeutic agents against the infections caused by the microbial MDR-agents. The genus Erythrina has further interest as sources of cancer chemopreventive agents and inhibitors of enzymes. Many bioactive substances isolated from this genus may lead to new phamaceuticals to be used in the therapy of cancer, obesity and diabetes type 2.

REFERENCES


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