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Erythrina Sacleuxii: A Review Of Is Traditional Uses, Phytochemistry And Pharmacology

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Abstract
Erythrina sacleuxii is a red-flowered 9–24 m tall tree of the family Fabaceae. It is endemic to Kenya, Tanzania and Mozambique. It has been used in the traditional medicinal system for the treatment of numerous diseases and conditions such as malaria and microbial infections. This review aims to comprehensively summarize the ethnomedicinal uses, chemical constituents and pharmacology of E. sacleuxii to explore its potential as a source for new therapeutic agents. Information was collected from scientific databases and books. Chemical structures were generated using ChemDraw Professional 15.0. To date approximately 60 compounds from this plant have been identified. Of the identified compounds 39 have been isolated with majority of them being flavonoids. The crude extracts and isolates have exhibited bioactivities, such as antiplasmodial, antimicrobial, cytotoxicity, antioxidant, antidiabetic, anti-inflammatory and analgesic validating some of its traditional medicinal uses. The major bioactivity that stands out is antiplasmodial. Plants in the genus Erythrina are known to be alkaloid rich; however there are no reports of alkaloids from this plant. In conclusion, E. sacleuxii is a potential source of new therapeutic agents. Further studies involving bioassay-guided isolation and characterization need to be carried out so as to discover the full potential of this plant. Secondly, the plant parts that have not been studied like the flowers, seeds and pods should be investigated. Toxicological assessment and preclinical studies on compounds with potent activity should be conducted.
Keywords: *Bioactivities, ethomedicinal, flavonoids, isolates, plants.*

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I. Introduction

Plants have been sources of medicines since ancient times. The use of plant-derived drugs for the treatment of diseases has a long and successful tradition. In a 2019 WHO global survey, the majority of member states (110 of 179) formally acknowledged that their population uses herbs as a health resource[1]. Plants are therefore an extremely important resource in healthcare. This necessitates continued research on medicinal plants.

The Erythrina genus in the family Fabaceae is comprised of over 115 species of trees, shrubs, and herbaceous plants that possess orange or bright-red flowers. They are found throughout the tropical and subtropical regions of the world[2,3,4]. 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[5]. These bright red flowers common among members of this genus have earned them the name "coral trees"[6]. The place of origin of the genus *Erythrina* is not exactly known, but it is suggested that it was probably in South America, since most of the supposed "primitive" groups within the genus are found there. 70 species are recognized in the Neotropics, 38 in Africa and Madagascar, and 12 in Asia and Australia[7].

Many plants in this genus have found use in traditional medicine in various parts of the world[8]. For example, in Kenya the bark and roots of *E. abyssinica* are used in the treatment of malaria, syphilis, trachoma and elephantiasis[9,10]. In Tanzania, a decoction of the roots of this plant is used to treat colic[11]. The bark of *E. berteroana* is used as poison antidote in India[12].

Reviews on the ethnomedicinal uses, phytochemistry, and pharmacological activities of a number of plants in the genus Erythrina are available. However, there is no documented comprehensive review on *E. sacleuxii* Hua. This review aims at filling this gap. It will also identify gaps in the scientific work that has been carried out on this plant to date. Identification of chemical compounds with potential for development into therapeutic agents will be done. Lastly, *E. sacleuxii* is classified as 'near threatened' in the IUCN Red List of Threatened Species, 2013 (http://www.iucnredlist.org/ Accessed on 15/9/2025). Therefore by highlighting the pharmacological potential of this plant the review will contribute to the conservation and sustainable utilization of this plant.

II. Materials And Methods

Information on *Erythrina sacleuxii* was collected from the scientific search engines: Web of science, Google Scholar, SciFinder, and PubMed. Books on medicinal plants were used as well. The classification of the plant was validated by World Flora Online Plant List. The chemical structures of isolated compounds from *E. sacleuxii* were drawn using ChemDraw Professional 15.0 software.

III. Results And Discussion

Taxonomy (Botany), Ecology and Geographic Distribution of *E. sacleuxii*

Taxonomy (Botany)

Kingdom – Plantae
Division – Tracheophyta
Class – Magnoliopsida
Order – Fabales
Family – Fabaceae
Genus – Erythrina
Species – *Erythrina sacleuxii*

It is a stiffly branched tree 9-24 m, with open rounded crown, grey-brown smooth bark that has ridges of scattered corky prickle-tipped emergences. It commences flowering before the leaves develop[14]. The flowers, fruits, stem and twigs of *E. sacleuxii* are shown in Figure 1 below:

A[15] B[16] C[17] D[18]

Fig. 1: *E. sacleuxii* A-Flowers B-Fruits C- Stem D-Twigs

Ecology

E. sacleuxii grows at an altitude of 0-450m in scattered-tree grasslands, bushlands, open woodlands and semi-deciduous and evergreen coastal forests. It is also as a relic in coconut and mixed plantations[14].

Geographic Distribution

Found in East tropical Africa in Southern Kenya, Tanzania and northern Mozambique[19].

Ethnomedicinal uses of *E. sacleuxii*

It is used in the treatment of malaria fever and microbial infections[20,21].

Phytochemistry of *E. sacleuxii*

The first report of phytochemicals from *E. sacleuxii* is by Yenesew *et al*.[22] who worked on the stem bark of this plant. More work has since been carried out on the plant by other researchers. A detailed literature study revealed that flavonoids are the major constituents of *E. sacleuxii*. The different types of flavonoids present include; flavanones, isoflavones, isoflav-3-enes, prenylated isoflavones, isoflavanone, coumestans and pterocarpans. Other classes of compounds present include; aldehydes, esters, etc. The isolated compounds are listed in Table 1 and their chemical structures are illustrated in Figs.1 to 4.

Flavonoids

Flavonoids of different classes have been isolated from the roots, stem and twigs of *E. sacleuxii*.

From roots

A total of 13 flavonoids of different subclasses have been reported from the root bark and root wood of *E. sacleuxii*. The flavonoids isolated from the root bark are pterocarpan: shinpterocarpin (**1**); isoflavones: corylin (**2**), erysubin F (**3**), 5-deoxy-3'-prenylbiochanin A (**4**); isoflavanone: prostratol C (**5**); isoflav-3-ene: 7, 4'-dihydroxy-2',5-dimethoxyisoflav-3-ene (**6**); flavanone: suberectin (**7**)[23]. From the root wood pterocarpans: cristacarpin (**8**) and phaseollidin (**9**); isoflavanone: prostratol C (**5**); isoflavones: orobol (**10**) and daidzein (**11**); coumestans: 3'-methoxy coumestrol (**12**) and coumestrol (**13**) have been isolated[24].

Twigs

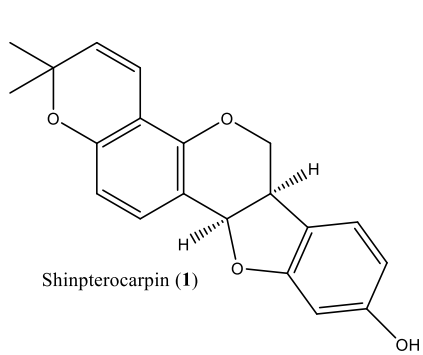
The following seven flavonoids of different subclasses have been isolated from the twigs of this plant. These are prenylated isoflavones: erysacleuxin C (**14**) and erysacleuxin D (**15**); isoflavones: genistein (**16**), 5′-formylpratensein (**17**) and calycosin (**18**); flavanones: liquiritigenin (**19**) and butin (**20**)[25].

Stem bark

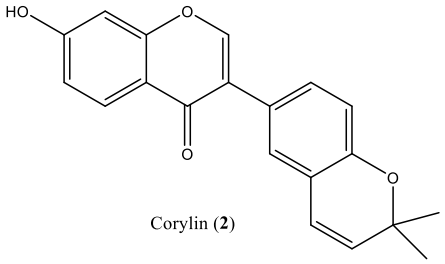
From the stem bark the following fourteen flavonoids have been isolated: prenylated isoflavones: erysacleuxin A (**21**) and B (**22**); isoflavones: 5′-formylpratensein (**17**), biochanin A (**23**), 5′-prenylpratensein (**24**), 7-demethylrobustigenin (**25**), 3′-prenyl)biochanin A (**26**),; isoflavanones: (*R*)-2,3-dihydro-7-demethylrobustigenin (**27**), (*R*)-saclenone (**28**), 2,3-dehydrokievitone (**29**); flavanones: abyssinone V (**30**), abyssinone V-4′-methyl ether (**31**), 4'-*O*-methylsigmoidin B (**32**), sigmoidin E (**33**), burttinone (**34**)[22,26].

Non-flavonoid constituents

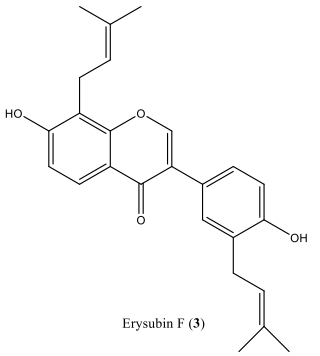
The following non-flavonoids have been isolated from the root bark: erythrinasinate (**35**), erythrinasinate A (**36**) *p*-hydroxybenzaldehyde (**37**), 26-hydroxyhexacosyl-(E)-ferulate (**38**) and vanillin (**39**)[23,25-27].



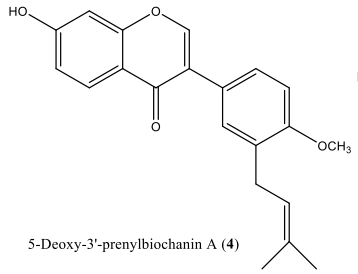
Shinpterocarpin (**1**)



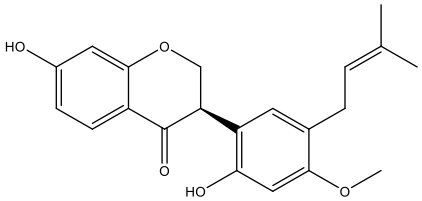
Corylin (**2**)



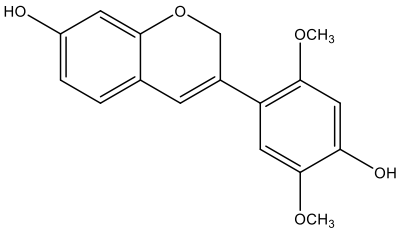
Erysubin F (**3**)



5-Deoxy-3'-prenylbiochanin A (**4**)



Prostratol C (**5**)



7,4'-Dihydroxy-2',5'-dimethoxyisoflav-3-ene (**6**)

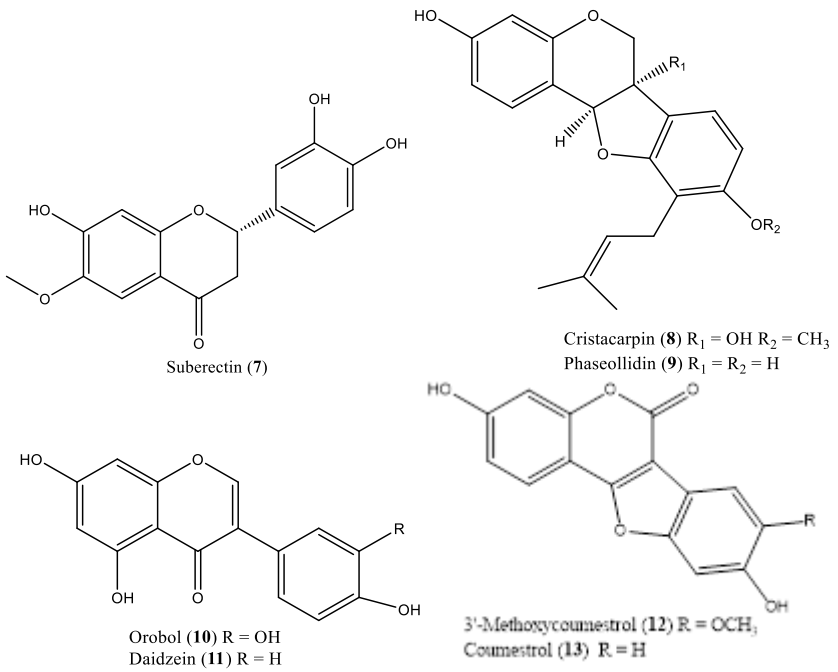


Fig 1: Flavonoids from the roots of *E. sacleuxii*

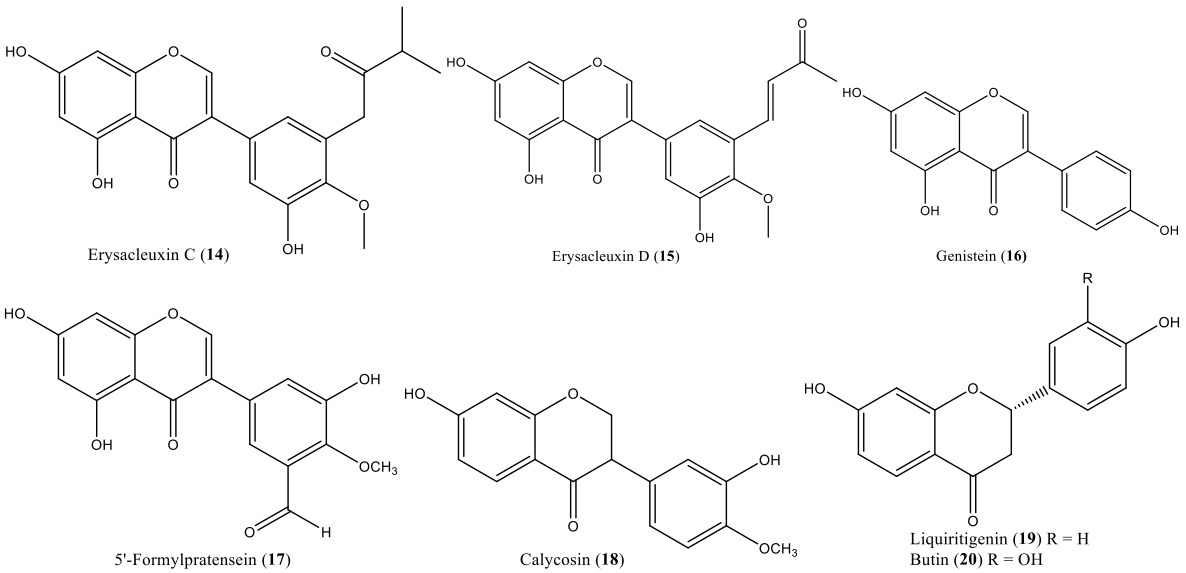
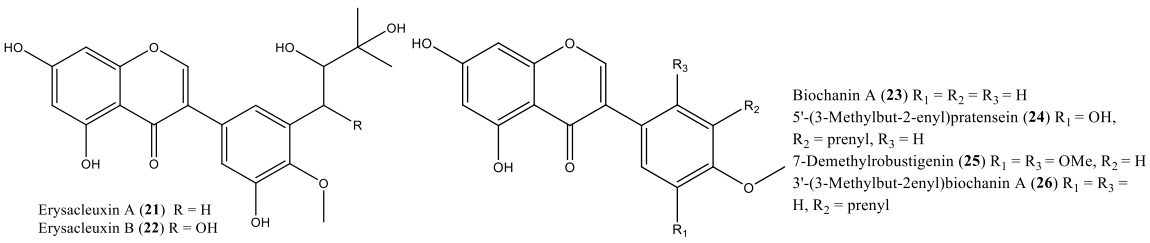


Fig. 2: Flavonoids from the twigs of *E. sacleuxii*



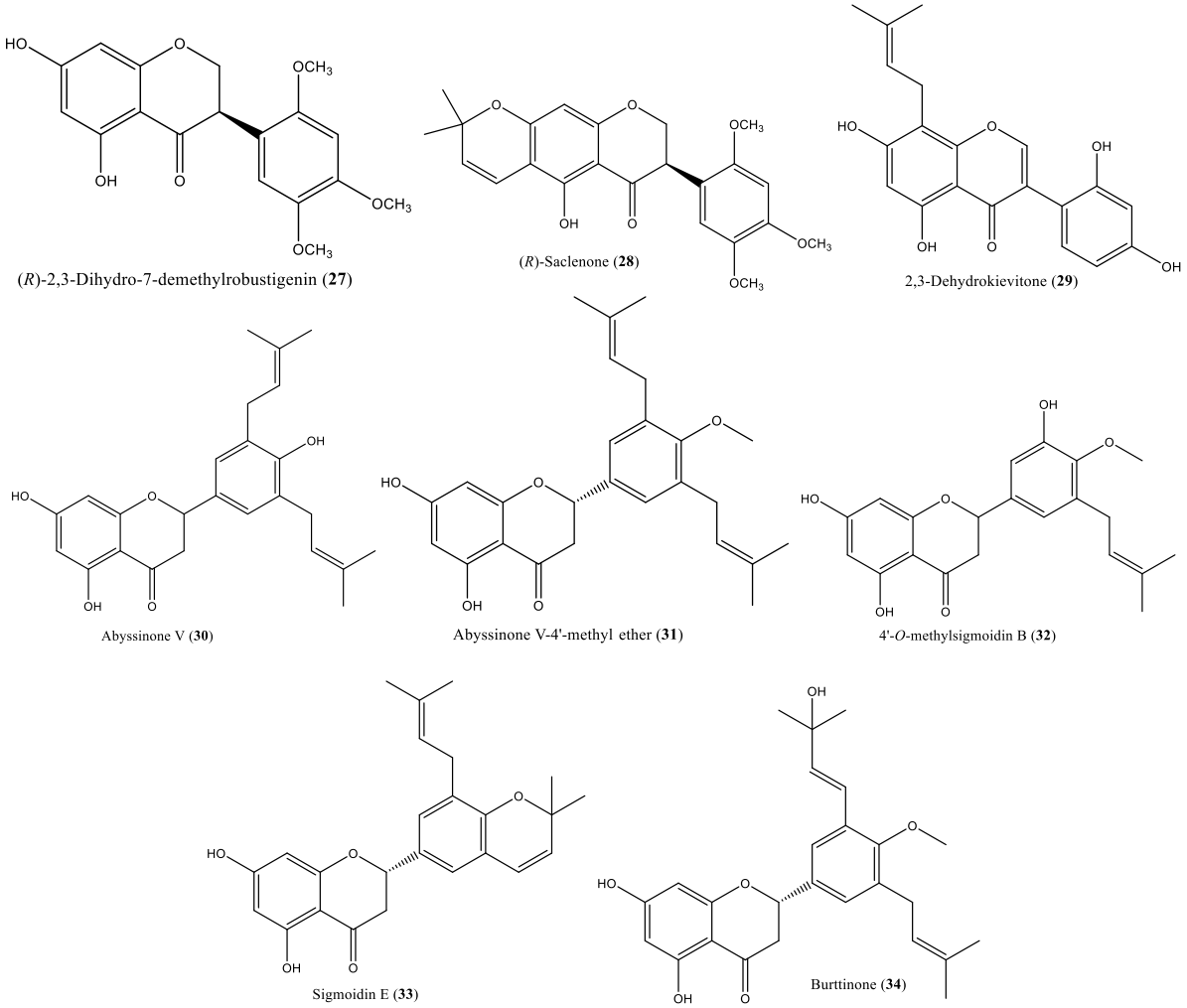


Fig. 3: Flavonoids from the stem bark of *E. sacleuxii*

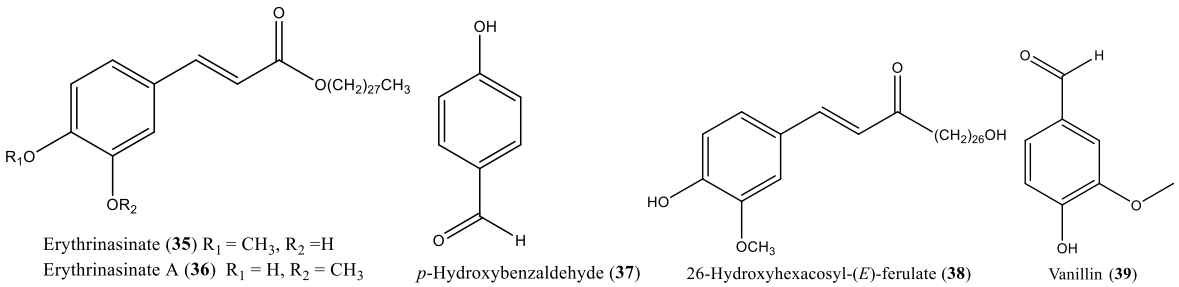


Fig. 4: Non-flavonoids from *E. sacleuxii*

Table 1: Compounds isolated from *E. sacleuxii*

Compound	Class	Plant part(s)	References
Shinpterocarpin (**1**)	Pterocarpan	Root bark	[23]
Corylin (**2**)	Isoflavone	root bark	[23]
Erysubin F (**3**)	Isoflavone	root bark	[23]
5-Deoxy-3'-prenylbiochanin A (**4**)	Isoflavone	root bark	[23]
Prostratol (**5**)	Isoflavanone	root bark and wood	[23,24]
7,4'-Dihydroxy-2',5-dimethoxyisoflav-3-ene (**6**)	Isoflavanone	root bark	[23]
Suberectin (**7**)	Flavanone	root bark and wood	[23,24]
Cristacarpin (**8**)	Pterocarpan	Root wood	[24]
Phaseollidin (**9**)	Pterocarpan	Root wood	[24]
Orobol (**10**)	Isoflavones	Root wood	[24]
Daidzein (**11**)	Isoflavone	Root wood	[24]
3'-Methoxycoumestrol (**12**)	Coumestan	Root wood	[24]
Coumestrol (**13**)	Coumestan	Root wood	[24]

Erysacleuxin C (**14**)	Prenylated isoflavone	Twigs	[25]
Erysacleuxin D (**15**)	Prenylated isoflavone	Twigs	[25]
Genistein (**16**)	Isoflavone	Twigs	[25]
5'-Formylpratensein (**17**)	Isoflavone	Twigs	[25]
Calycosin (**18**)	Isoflavone	Twigs	[25]
Liquiritigenin (**19**)	Flavanone	Twigs	[25]
Butin (**20**)	Flavanone	Twigs	[25]
Erysacleuxin A (**21**)	Prenylated isoflavone	Stem bark	[26]
Erysacleuxin B (**22**)	Prenylated isoflavone	Stem bark	[26]
Biochanin A (**23**)	Isoflavone	Stem bark	[22,26]
5'-Prenylpratensein (**24**)	Isoflavone	Stem bark	[22]
7-Demethylrobustigenin (**25**)	Isoflavone	Stem bark	[22]
3'-Prenylbiochanin A (**26**)	Isoflavone	Stem bark	[22]
(*R*)-2,3-Dihydro-7-demethylrobustigenin (**27**)	Isoflavanone	Stem bark	[27]
(*R*)-Saclenone (**28**)	Isoflavanone	Stem bark	[27]
2,3-Dehydrokievitone (**29**)	Isoflavanone	Stem bark	[27]
Abyssinone V (**30**)	Flavanone	Stem bark	[27]
Abyssinone V-4'-methyl ether (**31**)	Flavanone	Stem bark	[26]
4'-O-Methylsigmoidin B (**32**)	Flavanone	Stem bark	[27]
Sigmoidin E (**33**)	Flavanone	Stem bark	[26]
Burttinone (**34**)	Flavanone	Stem bark	[26]
Erythrinasinate (**35**)	Ferulate ester	Stem bark	[27]
Erythrinasinate A (**36**)	Ferulate ester	Root bark	[23]
p-Hydroxybenzaldehyde (**37**)	Aldehyde	root wood	[24]
Hydroxyhexacosyl-(*E*)-ferulate (**38**)	Phenolic	Twigs	[25]
Vanillin (**39**)	Phenolic	Twigs	[25]

Pharmacological activities

Crude extracts and isolates from *E. sacleuxii* are reported to possess a number of pharmacological activities. These include antiplasmodial, antioxidant, antidiabetic, anti-infammatory, antimicrobial and cytotoxic activities.

Antiplasmodial activity

Gessler *et al*.[20], screened ethanol, petroleum ether, ethyl acetate and aqueous leaves and root bark extracts of this plant *in vitro* against *Plasmodium falciparum* K1 strain. The four root bark extracts displayed good antiplasmodial activity with IC_{50} values of 80 µg/mL (aqueous), 10 µg/mL (ethanol), 3.6 µg/mL (petroleum ether) and 3.0 µg/mL (ethyl acetate). It is only the ethyl acetate extract amongst the four leaves extract that showed significant antiplasmodial activity with an IC_{50} value of 20 µg/mL. In a follow up study, Gessler *et al*. [28] subjected the root bark ethyl acetate extract which had displayed the highest activity according to the study by Gessler *et al*.[20] , to *in vivo* antiplasmodial assay. Mice infected with *P. berghei* were used. It was observed that the extract was inactive *in vivo* exhibiting a 9.2% parasitaemia suppression at a dose of 500 mg/Kg/day with a mean survival of 5.8 days. The root bark acetone extract of *E. sacleuxii* has also been tested in an *in vivo* 4-days *P. berghei* ANKA suppressive test at 800 mg/kg/day by Yenesew *et al*.[29]. The extract showed weak parasite suppression activity with 22.64 % average parasitaemia on day 4 and 37.4 % chemosupression.

The lack of activity of certain extracts or compounds *in vivo*, which are active *in vitro*, might be due to low absorption or because structures necessary for activity may be altered by metabolic processes. This is a phenomenon that has also been observed with other extracts and compounds as well[30,31]. Drugs or herbal medicines may also act by more than one mechanism, for example they may have an indirect effect on the immune system (e.g. biological response modifier) or other pathways that are not yet understood[32].

The antiplasmodial activity of the extracts of this plant is further confirmed in a study by Begum *et al*.[33]. In this study, the stem bark, root bark and leaves methanol extracts were subjected to *in vitro* antiplasmodial assay against *P. falciparum* 3D7 and HEK 293 strains. The three extracts displayed activity with IC_{50} values of 1.78, 0.45 and 24.59 µg/mL respectively against the 3D7 strain. The recorded IC_{50} values against the HEK 293 strain were 16.48, 4.02 and >400 µg/mL respectively. From these results, the roots extract emerges as the most active.

In a study by Andayi *et al*.[23], the crude extracts of the root and stem bark of *E. sacleuxii* together with and 16 flavonoids isolated from these extracts were evaluated *in vitro* for antiplasmodial activity against the chloroquine-sensitive (D6) and chloroquine-resistant (W2) strains of *Plasmodium falciparum*. The evaluated compounds were; **1**, **2**, **3**, **4**, **5**, **6**, **17**, **24**, **25**, **26**, **27**, **28**, **29**, **30**, **31** and **32**. The IC_{50} value for antiplasmodial activity of these compounds against the chloroquine-sensitive (D6) *P. falciparum* strain ranged between 4.9±0.8-28.0±5.3 µM. Compound **30** exhibited the highest activity against this strain with an IC_{50} value of 4.9±0.8 µM. On the other hand, the IC_{50} value for antiplasmodial activity of these compounds against the

chloroquine-resistant (W2) *P. falciparum* strain ranged between 6.1±1.3-31.8±6.1 µM. **30** exhibited the highest activity against this strain with an IC_{50} value of 6.1±1.3 µM. It was therefore the most active compound against both *P. falciparum* strains. The good antiplasmodial activity of **30** was further confirmed in a study by Yenesew *et al*.[29] in which **30**, **31** and **32** were subjected to antiplasmodial activity against D6 and W2 *P. falciparum* strains. Against the D6 strain, the three compounds displayed activity with IC_{50} values of 5.7, 10.7 and 12.4 µM respectively. The IC_{50} recorded against the W2 strain were 6.6, 11.9 and 12.7 µM respectively. The antiplasmodial activities of the compounds against the two strains were comparable suggesting same modes of action. These results displayed by the extracts and some isolates validate the use of this plant as an antimalarial in traditional medicine.

31 is among the compounds that have been subjected to *in vivo* antiplasmodium assay. When subjected to an *in vivo* 4-days *P. berghei* ANKA suppressive test, at 100 mg/kg/day, it did not show any significant activity[29].

Antimicrobial activity

Ombito *et al*.[24] evaluated **5**, **7**, **8**, **9**, **10**, **11**, **12**, **13** and **37** for *in vitro* antifungal activity against a panel of pathogens, including *Botrytis cinerea*, *Candida albicans*, *Eremothecium coryli*, *Penicillium notatum*, *Pyricularia oryzae*, and *Rhizomucor miehei*. Compounds **5** and **10** showed weak activity against *P. oryzae* with MIC values of 20 µg/mL. The rest of the compounds did not show any appreciable activity

An earlier study by Ombito *et al*.[26] had also evaluated 10 compounds isolated from the stem bark of *E. sacleuxii* for antifungal activity against the fungi above. The evaluated compounds were; **21**, **22**, **23**, **24**, **25**, **26**, **31**, **33**, **34** and **35**. Among the ten compounds evaluated in this study, only compounds **23**, **24** and **26** showed weak to moderate activity against *P. oryzae* and *R. miehei* relative to the positive control with MIC values of 176, 54 and 141µM, respectively. The positive control, ciclopirox had an MIC of 18µM.

31 has very strong antibacterial activity against *E. coli* and *K. pneumoniae*, with MIC of 3.9 mg/L, as well as strong activity against *S. aureus* and *B. subtilis*, with MIC of 31 and 15.6 mg/L, respectively[34]. In addition, it has strong activity against *B. cereus*, with MIC of 26 mg/L, good activity against *S. aureus* and *S. epidermidis*, with MIC values of 59 mg/L and 117 mg/L, respectively, as well as moderate activity against *E. coli* and *P. aeruginosa*, with MIC of 260 mg/L [35]. **34** has also been reported to possess strong antibacterial activity against *K. pneumoniae*, with MIC of 31 mg/L, as well as good activity against *B. subtilis* and *E. coli*, with MIC of 62 mg/L, and against *S. aureus*, with MIC of 125 mg/L[34].

11, **13** and **16** have antimicrobial activity against *Bacillus brevis* with MIC value of 35, 4.4 and 17.5 µg/ml respectively[36]. **16** has also been shown to possess antimicrobial activity against *E. coli*, *S. aureus*, *B. cereus* and *B. megaterium* with MIC values of 0.5 mg/ml against E. coli and 0.125 against each of the rest[37]. Another compound from *E. sacleuxii* with promising antimicrobial activity is **8**. In a study by Sadgrove *et al*.[35], it showed good activity against *P. aeruginosa*, with MIC of 78 mg/L, moderate activity against *B. cereus, S. aureus*, and *S. epidermidis*, with MIC values of 156 mg/L, 156 mg/L, and 412 mg/L, respectively, but low activity against *E. coli*, with MIC of 625 mg/L. Furthermore, it has good activity against MRSA (methicillin-resistant *Staphylococcus aureus*) with MIC of 100 mg/L[38].

Cytotoxic activity

Although *E. sacleuxii* is not used in cancer treatment in traditional medicine, other Erythrina species are used against cancer, e.g. stomach cancer, in folk medicine[39]. It has potential anticancer properties because its crude extracts and isolates have displayed good to moderate cytotoxic activities. In a study by Omosa *et al*.[40], two root bark extracts of this plant (one extracted with 50% n-hexane-CH_2Cl_2 and the other extracted with 50% CH_2Cl_2-MeOH) exhibited more than 50% inhibition of leukemia CCRF-CEM cells. The root bark ethyl acetate extract has also been reported to possess cytotoxic activity by Gessler *et al*.[28] This extract displayed cytotoxic activity against HT 29 and KB cells with an MIC value of 37 µg/mL against both cell lines. **14**, **15** and **20** have weak cytotoxicity against human cancer cell lines, HeLa-S3, with IC50 values of 130.4, 54.9 and 73.9 µM, respectively[24]. **34** exhibits cytotoxic effect on human cervix carcinoma KB-3-1 cells- IC_{50} 58.8 µM[41].

Pterocarpans **8** and **9** have also been screened for cytotoxicity. In a study by Dagne *et al*.[42], they were tested for activity against several cell lines. **9** was found to be moderately active in the wild-type CHOC cytotoxicity assay. Interestingly, **8** was inactive against wildtype CHOC but showed activity against a P-glycoprotein overproducing cell line; this reversal of activity is unusual. **8**, **9** and other pterocarpans have also been studied for their effects on H4IIE rat hepatoma cells[43]. **8** showed a moderate toxicity in H4IIE cells with EC_{50}-value of 75 µM whereas 9 showed prominent toxicity with EC_{50} values of 1.5 µM after 24 hours. In addition it was observed that **9**, induces apoptotic cell death at a dose of 2µM.

Antioxidant Activity

Crude extracts of different plant parts of plants in the genus Erythrina have been shown to possess antioxidant activity[44]. Although there is no report of the extracts of *E. sacleuxii* displaying antioxidant activity, some of the compounds isolated from its extracts possess antioxidant activity. For example, **8** has radical scavenging activity with IC_{50} value of 6.2 µg/ml[37]. **30** has also displayed moderate antioxidant activity with an EC_{50} value of 31.3 µg/mL in a Radical Scavenging Activity (RSA) assay against 2,2- diphenyl-1-picrylhydrazyl (DPPH) free radical, using spectrophotometric method[29].

Analgesic and Anti-inflammatory effects

Certain flavonoids are potent inhibitors of the production of prostaglandins, a group of powerful proinflammatory signaling molecules. Studies have shown that this effect is due to flavonoid inhibition of key enzymes involved in prostaglandin biosynthesis (i.e., lipoxygenase, phospholipase, and cyclooxygenase). Flavonoids also inhibit phosphodiesterases involved in cell activation[45]. **31** possesses anti-inflammatory activity[46]. At doses of 2.5, 5 10 mg/Kg, it produced a dose-related inhibition of edema formation in the carrageenan-induced paw edema test in rats. Another compound from this plant that possesses anti-inflammatory activity is **20**[47]. It has anti-inflammatory and anti-athritic properties in rats with complete Freund's adjuvant (CFA)-induced arthritis. Adminstration of 20 to CFA-treated animals significantlyattenuated the CFA-induced inflammatory response, oxidative stress, and reversed the histopatholocal alteration towards normal. Other compounds with anti-inflammatory activity from this plant include **2**[48] and **10**[45].

Antidiabetic activity

The Protein Tyrosine Phosphatase 1B (PTP-1B) is recognized as a key element in the regulation of insulin signal transduction pathways, and is unfortunately considered to be a negative regulator of the insulin receptor pathway along with the leptin receptor pathway[49]. Inhibiting this protein is a possible way of managing type 2 diabetes. **3** and **30** have been evaluated for their inhibitory effects on PTP-1B). **30** exhibited moderate dose-dependent activities whereas **3** showed good inhibitory activity with an IC_{50} value of 7.8 ± 0.5 µM[50]. This means that it has potential for management of diabetes type 2 and obesity by improving insulin sensitivity and increasing glucose uptake.

IV. Conclusion

The results validate ethnomedicinal uses of *E. sacleuxii*. This plant is a good source of bioactive compounds with majority being flavonoids. Some of the extracts and isolates have exhibited potent biological activities such as antiplasmodial, antimicrobial, antioxidant, antidiabetic, anti-inflammatory and analgesic and cytotoxic. Plants in the genus Erythrina are known to be alkaloid rich; however there are no reports of alkaloids from this plant. In conclusion, there is need for more studies involving bioassay-guided isolation and characterization to discover the full potential of this plant. Secondly, the plant parts that have not been studied like the flowers, seeds and pods should be investigated. Toxicological assessment and preclinical studies on compounds with potent activity need to be carried out.

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