Striga hermonthica (Del.) Benth: Phytochemistry and pharmacological properties outline

Faisal H.M. KOUA

ABSTRACT

This mini-review aims to outlining the beneficial impacts of the witch-weed parasitic plant; Striga hermonthica (Del.) Benth. S. hermonthica plant beside its well-known devastating impacts on the most important food cereal crops in Africa and is deemed to be one of the main factors that threatens the food security in this continent; it does also have a beneficial side in the tradition medicine for the African people. S. hermonthica has a wide range of medicinal uses; the pharmacological abortificient effect, dermatosis, diabetes, leprosy ulcer, pneumonia and jaundice remedy, trypanocidal effects, antibacterial and anti-plasmodial activities have been approved. Here, we focus mainly in the phytochemical studies, its applications in the remediation of both animal and human physiological and infectious diseases and Striga tissue culture advantage as biotechnological application for pharmaceutical production.

Key words: Parasitic plants, Striga hermonthica, seed germination, cereal crops, tissue culture, phytochemical screening, folkloric medicine.

INTRODUCTION

A witch-weed, Striga hermonthica (Del.) Benth is a flowering root parasitic plant and it is considered as a hemi-parasitic plant. S. hermonthica which belongs to the family Orobanchaceae (ex. Scrophulariaceae) is deemed to be one of the most ubiquitous parasitic weed of food crops, e.g., rice (Oryza sativa L.), millet (Pennisetum glaucum (L.) Leeke), maize (Zea mays L.) and sorghum (Sorghum bicolor L. Moench) roots (Press et al., 2001; Carson, 1988; Hutchinson and Dalziel, 1963; Tarr, 1962; Andrews, 1947). S. hermonthica is an erect annual, wide spread in the tropics and subtropics of Gambia, Ghana, Mali, Nigeria, Niger Republic, Senegal, Sudan, etc. (Choudhury et al., 1998). Striga has many vernacular names in different countries for example in Sudan named as 'Al Buda' and in West Africa, for example Nigeria named as 'Kudiji', 'Makasar dawa' (Killer of guinea corn), 'Dodon dawa' and 'Wuta wuta' (Choudhury et al., 1998). Beside its parasitic devastating impacts, S. hermonthica is well-known in some parts of Africa and India as a medicinal plant, where the plant is used for treatment of leprosy and leprous ulcers. In East Africa, a decoction or infusion of the roots is administered orally as an abortifacient and in the treatment of pneumonia (Kokwaro et al., 1976; Hiremath et al., 1997a) and anti-diabetic agent in western part of Sudan (EL-Kamali, 2009). Okpako and Ajaiyeoba (2004) reported that S. hermonthica extract has antimalarial activity; also it has been revealed that this plant has in vitro trypansomidal effect against Trypanosoma congoense and Trypanosoma cruzi (Atawodi et al., 2003). We also have screened preliminarily the antimicrobial activity of the plant, which revealed some activities against...
The parasite then emerges from the soil, develops chlorophyllous shoots (hemiparasitic stage) and a characteristic angiosperm root in order to interact with the host. Thus, the sterile culture technique has provided an opportunity for studying the parasite in isolation (Okonkwo and Raghavan, 1990; Dhingra et al., 2000). In vitro cultures may potentially constitute useful and easily manipulated systems for producing valuable biologically active compounds in plants that do not require labor-intensive methods. Since, the root parasites grow in close association with their hosts, the studies of parasite physiology and biochemistry cannot be carried out in situ without involving the host. Thus, the sterile culture technique has provided an opportunity for studying the parasite in isolation (Okonkwo and Raghavan, 1982). Tissue cultures are putative, to produce a variety of secondary plant products. The chemical interaction between the plant culture and their surrounding environment results in production of secondary metabolites. Hence, it is essentially important to define a culture medium that promotes the production.

The current mini-review is written with main objective to outlining the up-to-date reviews that have been focusing on the beneficial side of this parasitic plant. The application of its tissue culture on the phytochemistry and physiology will be considered as well.

**STRIGA HERMONTHICA: BIOLOGY AND IMPACTS**

**Geographic distribution**

*Striga* is mainly distributed in tropical arid and semi-arid zones with 400 to 1000 mm of annual rainfall. The origin of *S. hermonthica* is thought to be in the Nuba Mountains of Sudan and partly Ethiopia (Mohamed et al., 2001). The most severely affected countries are Mali, Upper Volta, Niger, Nigeria, Cameroon, Chad, Sudan, Ethiopia and India. In some regions of these countries where *Striga* is common, crop yields may regularly be reduced by 60-70%. Serious crop losses also occur widely in parts of the Gambia, Senegal, Mauritania, Togo, Ghana, Kenya, Tanzania, Uganda, Botswana, Swaziland and Mozambique and more locally elsewhere in Africa, Asia, Australia and the USA (Ayensu et al., 1984).

**Biology of S. hermonthica**

*S. hermonthica* is annual chlorophyllous plant grows up to 80 cm with hairy, hard guardrangle-shaped and fibrous stem, narrow leaf, and spike-shaped raceme inflorescence bearing up to 60 flowers for the terminal and 10 – 20 for the lateral inflorescence with bright pink, rose-red, white, or yellow color (Musselman, 1980). The root system in *Striga* is vestigial, in which the germinated seed radical produces haustorium instead of characteristic angiosperm root in order to interact with the host. The seeds are very tiny range between 0.15 ~ 0.3 mm in diameter and are estimated to be produced as high as 40,000 seeds per plant (Andrews, 1945). For germination *Striga* seed requires a period of pre-treatment, conditioning in a moist warm environment for 2 to 16 days before they have potential to germinate (Koua et al., 2011a; Longan and Stewart, 1991). *Striga* is the most economically important member of Scrophulariaceae family of parasitic plants, which attacks cereal crops, particularly sorghum, pearl millet, rice, maize, as well as tobacco and sugarcane in Africa, India, Asia, Australia, and some parts of the USA (Musselman, 1980). Its infection results in chlorosis, wilting, stunting, and death, with losses ranging from slight to 100 per cent (Agrios, 1997). After a connection being established between host and parasite, the parasite exhibits a holoparasitic subterranean stage of development at which time damage is inflicted. The parasite then emerges from the soil, develops chlorophyllous shoots (hemiparasitic stage) and produces flowers and seeds (Bagonneaud-Berthorne et al., 1995).

**In vitro culture applications in Striga**

*S. hermonthica* is well-known root parasitic angiosperm and entirely depends on its host plant to grow, hence the germinated seed requires a host tissue to stand for ascending
growth and for organic and inorganic nutrition sufficient for the early growth stage. Therefore, growing *Striga* in vitro without its host it’s been a challenge since long till the first in vitro growth has been developed by Okonkow (1966). In vitro seed germination and organogenesis of *S. hermonthica* and other *Striga* species have been utilized since the first report of Okonkow (1966) to mainly focus in the investigation of the parasitism physiology, biochemistry and the development of bio-control system (Rousset et al., 2003; Okonkow, 1991; Wolf et al., 1991; Yoshikawa et al., 1978). The research on *Striga* is overwhelmed by its economic impact as parasitic plant, due to its very devastating implications on food crops that threatening the food security in developing countries. Nevertheless, several articles concerning the pharmacological applications of *Striga* genus in some part of Africa and India have been released (Atawodi et al., 2003; Choudhury et al., 2000; Hiremath et al., 1997a,1996). Till recently, all of these studies concerning the medicinal uses were focused in the use of the whole plant and/or some parts of the intact plant to study the phytochemistry and its medicinal applications. Very recently, we took the advantage of in vitro culture to establish an in vitro system for callus production suitable for biochemical/phytochemical analysis, which provides a good basis for further studies (koua et al., 2011a).

**Striga phytochemistry and Pharmacological activities**

Medicinal plants have been an integral part of the ethnobotanical aspects of the people. The modern medicine has evolved from folk medicine and traditional system only after thorough chemical and pharmaceutical screening. Advanced microbial and chemical methods can synthesize medicinal and aromatic compounds, but the cost in many cases is expensive. Thus, plants remain the major source of medicinal compounds. UNESCO (1998) estimated that 20,000 plant species are used for medicinal purposes. Farnsworth et al., (1985) recorded that 74% of 119 plants-derived drugs were discovered as a result of chemical studies to isolate the active substances responsible for their traditional use.

Despite the intense uses of *S. hermonthica* as medicinal plant and the researches concerning the agricultural importance of this plant, the thorough phytochemistry knowledge still scarce (Koua et al., 2011b). In this mini-review we summarized the phytochemical contents and their medicinal properties (Table 1).

The preliminary phytochemical screening of this plant showed the presence of terpenes, saponin, cardiac glycosides, alkaloids, anthrocenocides, coumarins, tannins and flavonoids (Koua et al., 2011b; Atawodi et al., 2003). Kiedrebeogo and his coworkers were studied the composition and antioxidant properties of the aqueous extract, which exhibits antioxidant activity using 2,2-diphenyl-1-picrylhydrazyl (DPPH). This antioxidant property was attributed to the intense presence of polyphenolic compounds with 4% flavonoids (mainly as luteolin), 2.26% tannins and 0.14% anthocyanins (Kiedrebeogo et al., 2005). The iridoid-derived monoterpene alkaloid venoterpin has also been isolated from *S. hermonthica* (Baoua et al., 1980). Moreover, in different studies *S. hermonthica* is used for the treatment of leprosy and leprous ulcers. In East Africa, a decoction or infusion of the roots is administered orally as an abortifacient and in the treatment of pneumonia (Kokwaro, 1976). In northern Nigeria, a decoction of the plant in dry and fresh leaves is rubbed onto the skin for the treatment of fungal infections. Also, the pharmacological studies showed that a methanol extract of the plant has a contractile effect on the isolated rat uterus by interacting with muscarinic receptors on the smooth muscle of the uterus in a manner similar to acetylcholine (Choudhury et al., 1998). Moreover, the flowers of *Striga* species are used locally in Nigeria to prevent conception. Studies by Choudhury and his co-workers in 1998 validated the use of the plant as an antifertility agent. The methanolic extract of the whole plant was displayed a weak activity with IC$_{50}$ 274.8 µg/ml against plasmodium parasite. However the same tested extract showed higher intrinsic antimalarial activity with 68% suppression (in vivo) against chloroquine-sensitive Plasmodium berghei (ANKA P1) with dose of 400 mg/ kg weight of mice (Okpako and Ajayiebo, 2004). In addition, the alcohol extract of *S. hermonthica* revealed antitrypanocidal effect against and *Trypanosoma cruzi* and *Trypanosoma congolense* (Atawodi et al., 2003), and it also shows antibacterial properties to some limit against *Staphylococcus aureus, E. coli, Pseudomonas*

<table>
<thead>
<tr>
<th>Phytochemical group</th>
<th>Plant parts</th>
<th>Extracting solvent</th>
<th>References*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavonoids</td>
<td>shoot, haustoria, flowers, whole plant, callus</td>
<td>alcohol, aqueous</td>
<td>A,B,C,D,E</td>
</tr>
<tr>
<td>Tannins</td>
<td>shoot, haustoria, whole plant, callus</td>
<td>acetone, ethylacetate</td>
<td></td>
</tr>
<tr>
<td>Saponins</td>
<td>shoot, haustoria, whole plant, callus</td>
<td>aqueous, alcohol</td>
<td>A, B</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>shoot, haustoria, whole plant, callus</td>
<td>aqueous</td>
<td>A, B</td>
</tr>
<tr>
<td>Terpenes/Sterols</td>
<td>shoot, haustoria, whole plant, callus</td>
<td>petroleum ether,</td>
<td>A</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>shoot, haustoria, whole plant, callus</td>
<td>aqueous, alcohol</td>
<td>A, F</td>
</tr>
<tr>
<td>Anthracenosides</td>
<td>haustoria</td>
<td>aqueous</td>
<td>A</td>
</tr>
<tr>
<td>Coumarins</td>
<td>haustoria, callus</td>
<td>aqueous</td>
<td>A</td>
</tr>
<tr>
<td>Volatile oils</td>
<td>whole plant</td>
<td>not determined</td>
<td>B</td>
</tr>
</tbody>
</table>

*References*: A) Koua et al., (2011a,b); B) Okpako and Ajayiebo (2004); C) Kehrebeogo et al., (2005); D) Khan et al., (1998); E) Choudhury et al., 2000; F) Baoua et al., (1980)

<table>
<thead>
<tr>
<th>Striga species</th>
<th>Pharmacological activity</th>
<th>References*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. hermonthica</em></td>
<td>bacteroicidal, fungicidal, trypanocidal, anti-plasmodial, contraceptive, abortifacient, antioxidant</td>
<td>A,B,C,D,E, G</td>
</tr>
<tr>
<td><em>S. sulphurea</em></td>
<td>bactericidal</td>
<td>H</td>
</tr>
<tr>
<td><em>S. densiflora</em></td>
<td>bactericidal</td>
<td>I</td>
</tr>
<tr>
<td><em>S. orobanchoideas</em></td>
<td>bactericidal, fungicidal, anti-oxidant, anti-androgenic, anti-histaminic, antifertility</td>
<td>I, J, K, L</td>
</tr>
<tr>
<td><em>S. lutea</em></td>
<td>antifertility</td>
<td>I</td>
</tr>
</tbody>
</table>

T. aeroginosa and Candida albicans (Koua et al., 2011b), however, in the same study the aqueous extract of the callus showed activity only against Ps. aeroginosa (Table 1). The aqueous extract of also showed less antihelminthic activity against Rhavditid nematode and Caenorhabditis elegans (Ibrahim 1992). The plant extract was also screened for its insecticidal activity which resulted in 48 – 51% ovicidal and 72% larvicidal properties of the beetles Callibruchus maculatus (Kiendrebego et al., 2006). As stated in Table 2, other Striga species have been also approved for their pharmacological activities for example the petroleum ether extracts of S. desiflora Benth and S. orobachioredes benth were showed activities against pathogenic and nonpathogenic bacteria (Hiremath et al., 1996). It also has been revealed that the ethanolic extract of S. sulphurea exhibited activities against S. aureus, E. coli, Ps. aeruginosa and Aspergillus niger (Hiremath et al., 1997a). All these might effectively approve the intense traditional uses of the genus Striga as pharmaceutical agents for many diseases.

CONCLUSION

*S. hermonthica* is a well-known medicinal plant that has been used widely in the traditional medicine of Africa with broad spectrum of pharmacological impacts against many physiological and infectious diseases in both animal and human. From the available Nevertheless, the information about the phytochemicals and its pharmacologic effects are still scarce. More comprehensive research is very required to conclude thoroughly on the intense usages of this plant in the traditional medicine of Africa. The ovicidal and larvicidal properties revealed by this plant would be of great importance to be implemented in the mosquitoes management in Africa. The later is also a place of prospective researches to be done for more appraisals.

REFERENCE


