Journal of Applied Pharmaceutical Science

Available online at www.japsonline.com

ISSN: 2231-3354
Received on: 02-09-2011
Revised on: 05-09-2011
Accepted on: 08-09-2011

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

Faisal H.M. KOUA

Faisal H.M. KOUA
[a]*Department of Biochemistry, Faculty of Science and Technology, Al-Neelain University, Khartoum, Sudan.*
[b] *Division of Bioscience, Graduate School of Natural Science & Technology, Okayama University, Okayama 700-8530, Japan*

***For Correspondence*:**
Faisal H.M. KOUA
Division of Bioscience, Graduate School of Natural Science & Technology, Okayama University, Okayama 700-8530, Japan
Tell: *+249-183-780058*

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-plasmoidal 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, 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* trypanocidal effect against *Trypanosoma congolense* and *Trypanosoma cruzi* (Atawodi et al., 2003). We also have screened preliminarily the antimicrobial activity of the plant, which revealed some activities against

Fig 1 *Striga hermonthica* (Del.) Benth:
Source: https://www.uni-hohenheim.de/ipspwww/350b/indexe.html

Pseudomonas aeruginosa, *Candida albicans*, *E. coli* and *Staphellococcus aureus* (Koua et al., 2011b). Generally, plants have been an important source of medicine for thousands of years. Even to-day, the World Health Organization (WHO) estimates that up to 80 per cent of people still rely mainly on traditional remedies such as herbs for their medicines (Tripathi and Tripathi, 2003). The use of medicinal plants all over the world predates the introduction of antibiotics and other modern drugs into the African continent. Herbal medicine has been widely used and formed an integral part of primary health care in China (Liu, 1987), Ethiopia (Desta, 1993), Argentina (Anesini, 1993) and Papua New Guinea (Nick et al., 1995).With few exceptions, such as the cytotoxic protein ricin (Hartley and Lord, 1993), most of the pharmacologically active compounds found in plants are the products of secondary metabolism. Secondary metabolites have been defined as all those metabolites in plant that do not appear to be indispensable to the species concerned or ubiquitous in all species (Vickery and Vickery, 1981).

Natural habitats for medicinal plants are disappearing fast due to different instability factors; therefore, difficulty to acquire plant-derived compounds is increasing (Mulabagal and Tsay, 2004). An alternative to field-grown crops or to chemical synthesis has been large-scale in vitro plant tissue culture (Francois et al., 1990; Dhingra et al., 2000). *In vitro* cultures may potentially constitute useful and easily manipulated systems for producing valuable biologically active compound 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, thence 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 organogesis 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

Table 1: Summary of the phytochemical contents extracted from *S. hermonthica*

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

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

Table 2: Some of the pharmacological properties of the genus *Striga*

***Striga* species**	**Pharmacological activity**	**References***
S. hermonthica (Del.) Benth	bacteriocidal, fungicidal, trypanocidal, anti-plasmoidal, contraceptive, insecticidal, abortifacient, antioxidant	A,B,C,D,E, G
S. sulphurea	bacteriocidal	H
S. densiflora Benth	bacteriocidal	I
S. orobanchioiedes Benth	bacteriocidal, fungicidal, anti-oxidant, anti-androgenic, anti-histaminic, antifertility	I, J,K, L
S. lutea	antifertility	I

References*: A through E referenced in Table 1; G) Hussain and Deeni (1991); H) Hiremath et al., (1997a); I) Badami et al., (2003); J) Harish et al., (2001); K) Hiremath et al., (2000); L) Hiremath et al., (1997b).

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 plant 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 berghi* (ANKA P1) with dose of 400 mg/ kg weight of mice (Okpako and Ajaiyeoba, 2004). In addition, the alcohol extract of *S. hermonthica* revealed antitrypanocidal effect against and *Trypanosoma cruzi cruzi* and *Trypanosoma congolense* (Atawodi et al., 2003), and it also shows antibacterial properties to some limit against *Staphyllococcus aureus*, *E. coli*, *Pseudomonas* *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 *Callobruchus maculatus* (Kiendrebeogo 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 (Hirematch et al.,1996). It also has been revealed that the ethanolic extract of *S. sulphurea* exhibited activities against *S. aureus*, *E. coli*, *Ps. aeruginsoa* 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

Agrios GN. Plant Pathology, 4th ed. Academic Press, San Diego, CA (1997) 635.

Andrews R.W. The parasitism of *Striga hermonthica* Benth on leguminous plants. Ann. Appl. Biol. 1947; 34: 267-275.

Andrews, R.W. The parasitism of *Striga hermonthica* Benth on *Sorghum spp.* under irrigation, Ann. Appl. Biol. 1945; 32: 193-200.

Anesini C., Perez C. Screening of plants used in Argentine folk medicine for antimicrobial activity. J. Ethnopharmacol. 1993; 39: 119-128.

Atawodi S.E., Bulus T., Ibrahim S., Ameh D.A., Nok A.J., Mamman M., Galadima M. In vitro trypanocidal effect of methanolic extract of some Nigerian savannah plants. Afr. J. Biotechnol. 2003; 2: 317-321.

Baoua M., Bessiere J.M., Pucci B., Rigaud J.P. Alkaloids from *Striga hermonthica*. Phytochemistry. 1980; 19: 718.

Carson A.G. (1988). *Striga*: Improved management in Africa. In T.O. Robson & Broad H.R. (Eds.) on *Striga* Control. Proceedings of FAO/OAU All- Africa Government Consultation (p 205). Maroua, Cameroon.

Choudhury M.K., Phillips A.L., Mustapha A. Pharmacological studies of *Striga senegalensis* Benth. (Scrophulariaceae) as an Abortifacient. Phytother. Res. 1998; 12: 141-143.

Desta B. Ethiopia traditional herbal drugs part II: antimicrobial activity of 63 medicinal plants. J. Ethnopharmacol. 1993; 42: 129-139.

El-Kamali H.H. Ethnopharmacology of Medicinal Plants used in North Kordofan (Western Sudan). Ethnobot. leaflets. 2009; 13: 203-210.

Ejeta G. Breeding for *Striga* resistance in *Sorghum*: Exploitation of an Intricate Host-Parasite Biology. Crop Science. 2007; 47: 216-227.

Farnsworth N.R., Akerlete O., Bingel A.S., Guo Z.G., Soejarto D.D. Medicinal Plants in Therapy. World Health Organization, Bulletin. 1985; 63: 965-981.

Harish M.S., Nagur M., Badami S. Antihistaminic and mast cell stabilizing activity of *Striga orobanchioides*. J. Ethnopharmacol. 2001; 76: 197 – 200.

Hartley M.R., Lord J.M. (1993). Structure, function and applications of ricin and related cytotoxic proteins. In D. Grieso (Ed.) Biosynthesis and Manipulation of Plant Products (pp. 210-239). Blackie Academic and Professional, London.

Hiremath S.P., Badami S., Hunasagatt, S.K., Patil S.B. Antifertility and hormonal properties of flavones of *Striga orobanchioides*. Eur. J. Pharmacol. 2000; 391: 193 – 197.

Hiremath S.P., Rudresh K., Bandami S. Antimicrobial activity of various extracts of *Striga sulphurea* and *Heridesmus indicus*. Indian J. Pharm.Sci. 1997a; 59: 145-147.

Hiremath S.P., Badami S., Swamy H.K.S., Londonkar R.L., Patil S.B. Anti-androgenic effect of *Striga orobanchioides*. J. Ethnopharmacol. 1997b; 56: 55–60.

Hiremath S.P., Swamy H.K.S., Badami S. Meena S. Antimicrobial and antifungal activity of *Striga densiflora* and *Striga orobanchioiedes*. Indian J. Pharm. Sci. 1996; 58: 174-176.

Hussain H.S., Deeni Y.Y. Plants in Kano ethnomedicine; screening for antimicrobial activity and alkaloids. Intr. J. Pharmacog. 1991; 29: 51 – 56.

Hutchinson J., Dalziel J.M. (1963). Flora of West Tropical Africa. In F.N. Hepper (Ed.) Published on behalf of the Governments of Nigeria, Ghana, Sierra Leone and Gambia (pp. 370-373). Crown Agents for Overseas Governments and Administrations, Milbank, London SW1.

Ibrahim A.M. Antihelmintic activity of some Sudanese medicinal plants. Phytother. Res. 1992; 6: 155-157.

Khan I.Z., Aqil M., Kolo B. 5-hydroxy-6,8-dimethoxyflavone 7,4`-*O*-diglucoside from *Striga hermonthica* (Del.) Benth. Ultra Sci. Phys. Sci. 1998; 10: 278 – 280.

Kokwaro J.O. (1976). Medicinal Plants in East Africa. In L. Van Puyvelde and Geysen D. (Eds.) East African Literature Bureau (pp. 92-93, 203), Nairobi, Kenya.

Koua F.H.M., Abbass F.M., Elgaali E.I., Khalafallah M.M., Babiker H.A.A. In vitro host-free seed culture, callus development and organogenesis of an obligatory root-parasite Striga hermonthica (Del.) Benth: the witch weed and medicinal plant. Intr. J. Plant Biol. 2011a; 2: 34 – 39.

Koua F.H.M., Babiker H.A.A., Halfawi A., Ibrahim R.O., Abbas F.M., Elgaali E.I., Khalafallah M.M. Phytochemical and biological study of *Striga hermonthica* (Del.) Benth Callus and Intact Plant. Res. Pharma. Biotechnol. 2011b; 3: 85-92.

Logan D.C., Stewart G.R. Role of ethylene in the germination of the hemiparasite, *Striga hermonthica*. Plant Physiol. 1991; 97: 1435-1438.

Liu C.X. Development of Chinese medicine based on pharmacology and therapeutics. J. Ethnopharmacol. 1987; 19: 119-123.

Musselman L.J. The biology of *Striga*, *0rbanche*, and other root-parasitic weeds. Ann. Rev. Phytopathol. 1980; 18: 463-89.

Nick A., Rali T., Sticher O. Biological screening of traditional medicinal plants from Papua New Guinea. J. Ethnopharmacol. 1995; 49: 147-156.

Okonkwo S.N.C. (1991). *In vitro* growth response of cultured germinated seeds of witchweed (*Striga asiatica*). In M. Ransom, Musselman L.J., Worsham A.D., Parker C. (Eds.) Proceedings of 5th International Symposium on Parasitic Weeds (pp.155 – 163). Nairobi, Kenya.

Okonkwo S.N.C. Studies on *Striga senegalensis* I. In vitro culture of seedlings. Effect of various sugars and glutamine. Am. J. Bot. 1966a; 53: 687-93.

Okpako L.C., Ajaiyeoba E.O. In vitro and in vivo antimalarial studies of *Striga hermonthica* and *Tapinanthus sessilifolius* extracts. Afr. J. Med. Sci. 2004; 33: 73-75.

Press M.C., Scholes J.D., Riches C.R. (2001). Current status and future prospects for management of parasitic weeds (*Striga* and *Orobanche*). In C.R. Riches (Ed.) The World's Worst Weeds (pp 71–90). British Crop Protection Council, Brighton, UK.

Tarr S.A.J. Disease of Sorghum, Sudan Grass and Broom Corn. The Commonwealth Mycological Institute, CAB international, Kew, Surry, U.K (1962) 229-302.

Tripathi L., Tripathi T.N. Role of biotechnology in medicinal plants. Trop. J. Pharm. Res. 2003; 2: 243-253.

UNESCO (1998). FIT/504-RAF-48 Terminal Report: of Ethnobotany and the Sustainable Use of Plant Resources in Africa, (p60) Paris, France.

Vickery M.L., Vickery B. Secondary Plant Metabolism. 7 Compounds with a mixed biogenesis. Macmillan Press Limited, London (1981) 183–254.

Wolf S.J., Timko M.P. In vitro root culture: a novel approach to study the obligate parasite *Striga asiatica* (L.) Kuntze. Plant Sci. 1991; 73: 233-242.

Yoshikawa F., Worshama A.D., Moreland D.E. Eplee R.E. Biochemical requirements for seed germination and shoot developmenot f witch*weed (Striga asiatica)*. Weed Sci. 1978; 26: 119-122.