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Review

Benefits and detriments of Siam weed (*Chromolaena odorata*): A review

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ABSTRACT

Siam weed (*Chromolaena odorata*) (L.) R.M. King & H. Robinson) belonging to the family Asteraceae, originating from South and Central America, is a bushy shrub invasive in many tropical and subtropical regions of the world. This article reviewed the issues of medicinal, nutritional and usefulness of *C. odorata*, in agriculture settings as well as weedy nature of the plant as documented by some researchers. The screening of crude, aqueous, and ethanolic leaf extracts of *Chromolaena odorata*, for its phyto-constituents and investigation of antioxidant, antibacterial, molluscicidal activity, larvicidal activity and wound healing properties were reviewed as documented by some researchers. The literature review revealed that *C. odorata*, secondary metabolites include alkaloids, flavonoids, phenolics, saponins, steroids and tannins. The reports of the scientific investigations revealed that *C. odorata* have antioxidant, antibacterial and wound healing properties. It was equally documented for its molluscicidal, larvicidal and immunomodulating activity. The presence of the active secondary metabolites in *C. odorata* suggested its basis for its effectiveness as ethno pharmacological hence justifies its therapeutic traditional usage. The review revealed that *C. odorata* is a source of high quality protein which could serve as potential source of protein supplement and this could explain its folkloric use in animal nutrition. The review revealed that *C. odorata* is highly adaptive and a potential threat to native plant biodiversity and agro-ecosystem sustainability however the species is reported to be beneficiary as fallow plant considering the expected properties of species for fallow improvement. It is finally concluded that *C. odorata* be investigated more in order to harness its benefits in term of medicinal properties, livestock nutrition and agricultural uses.

Keywords: *Chromolaena odorata,* phyto-constituents, medicinal properties, agricultural benefits.

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INTRODUCTION

Siam weed (*Chromolaena odorata*) (L.) R.M. King & H. Robinson) belonging to the family Asteraceae, formerly called *Eupatorium odoratum*, a plant with a characteristic aromatic smell, since ancient times, had been of interest for medical purposes in the local parlance and had been reported to be used in tradition medicine as antispasmodic, antiprotozoal, antitrypanosomal, antibacterial, antifungal, antihypertensive, anti-inflamatory, astringent, diuretic and hepatotropic agent (Akinmoladun et al., 2007). It is an herbaceous, perennial, semi woody shrub that forms dense tangled bushes about 1.5 to 2.0 m in height (Phan, 2001). It is a weedy pioneering shrub native to the Americas (Gautier, 1992). It has been introduced into diverse ecological areas of tropical lands from Southern Mexico (Owolabi et al., 2010). It has become one of the worst terrestrial invasive plants in the humid tropics and subtropics of the old world over the past century (Gautier, 1992). *C. odorata* is a scrambling perennial shrub, with straight, pithy, brittle stems which branch readily, bear three-veined, ovate-triangular leaves placed oppositely, and with a shallow, fibrous root system (Henderson, 2001) (Figure 1). Within its native range, *C. odorata* shows marked morphological variability in terms of flower colour, leaf shape and hairiness, smell of the crushed leaves, and plant architecture. In some regions, several forms and their intermediates co-occur, while in others, the population appears homogeneous; the basis for this

Figure 1. *Chromolaena odorata* (Siam weed).

variability presently remains unexplained (Zachariades et al., 2004)

C. odorata is called 'Independence' leaf, ewe 'Awolowo', Akintola taku' by the Yorubas; 'obu inenawa' by the Igbos, two major tribes in Nigeria. Siam weed is recognized as one of the world's worst tropical weeds. It has an extremely fast growth rate (up to 20 mm per day) and prolific seed production (Owolabi et al., 2010). In the tropics of Africa and Asia it has become agricultural weeds. It grows on most soil types but prefers well drained soils in full sun. It has a competitive advantage over other plants in climates with distinct wet and dry seasons because it survives fires and propagates back briskly following rain. Siam weed being an invasive, fast growing plant, thrives in disturbed areas such as clearings, pastures, roadsides, river banks and plantations particularly those in well-lit sites. Siam weed is on the alert list as environmental weeds that threaten biodiversity and cause other environmental damage, yet, *C. odorata* in tropical Africa has attained repute as medicinal herb. The aim of this review paper is to present selected research and findings which considered *C. odorata* as a medicinal plant, nutraceutical and weed or as a beneficial fallow plant in order to harness its benefits and guide against its perils.

Health benefits of *Chromoleana odorata*

The World Health Organization has recommended that the use of plant traditionally to treat different infections should be encouraged especially in countries where access to the conventional or orthodox treatment is not adequate (WHO, 1980). Hedberg (1993) reported that about eighty percent of the western pharmaceuticals have their origin in plants. WHO (1976); Akinmoladun and Akinloye (2007) also pointed out that organs of the medicinal plant contained substances that could be used for the therapeutic purposes and or the precursors useful for synthesis of drugs; and they contain nutrients that can heal the body (Trease and Evans, 1985). Okwu (1999) reported that many of indigenous medicinal plants are used as spices and food plants; they are also sometimes added to foods for medicinal purpose. Various medicinal plants, *C. odorata* inclusive had been studied using modern scientific approaches. The studies had shown that many medicinal plants have a variety of properties and they could be used to treat various diseases due to the presence of various biological active compounds in them.

The screening of plants for chemicals to find new pharmaceuticals was rapidly on the increase. *C. odorata* was screened using different methods. Many researchers had screened *C. odorata,* to ascertain its bioactive compounds, among these was a trial in which aqueous and ethanolic extracts of *C. odorata* leaves were screened by Anyasor et al. (2011) and in another experiment carried out by Tiamiyu *et al. (*2019) to evaluate haematological and serum protein of African Catfish (*Clarias gariepinus*) juveniles fed with *C. odorata* as feed additives, the dried leaf powder of *C. odorata* was screened for its bioactive constituents, the results of both experiments are shown in Tables 1 and 2, respectively.

The reported studies as have shown above indicated that *C. odorata* have bioactive compounds both in fresh as well as in dried powder therefore biological effects attributed to Siam weed could have been ascribed to the presence of reasonable amount of bioactive compounds such as alkaloids, flavonoids, phenolics, saponins, steroids and tannins as styled by Bamisaye et al. (2014) and these could be the factors responsible for various biological and health benefits ascribed to *C. odorata* as detailed in various scientific studies shown in Table 3.

The medicinal values of the plants lie in their phytochemical components, which produce definite physiological actions on the man and animal body. Hill (1952) described most important of these phytochemicals of plants as alkaloids, tannins, flavonoids and phenolic

Table 1. Phytochemical analysis of aqueous and ethanolic leaf extracts of *Chromolaena odorata.*

Bioactive compounds	Relative abundance	
	Aqueous	Ethanolic
Terpenoids	-	++
Tannin	+	++
Saponin	++	+
Phlobatannin	++	-
Cardiac glycoside	-	++
Flavonoids	-	-
Cardenolides	-	-
Anthraquinones	-	+
Phenol	++	+
Alkaloid	++	-
Volatile Oil	-	-

Observation Remarks: ++ = *abundant* + = *trace* - = *absent.* Source: Anyasor et al. (2011).

Table 2. Phytochemical analysis of dried leaf powder of *Chromolaena odorata.*

Bioactive compounds	Relative abundance
Alkaloids	+ + +
Tannin	+ + +
Phlobatannin	+ +
Saponin	+ + +
Flavonoids	+
Anthraquinones	-
Steroids	+
Terpenes	+
Cardenolides	-
Phenol	+ + +
Chalcones	-
Cardiac glycoside	++

Observation Remarks: + + + = Appreciable Amount Present, + + = Moderate Amount Present, + = Trace Amount Present, - = Completely Absent. Source: Tiamiyu et al. (2019).

Table 3. Different scientific reports pronounced on *Chromolaena odorata.*

S/N	References	Objective of investigation	Form and part of the plant used for the trial	Author submission/ conclusion
[1]	Anyasor et al., 2011	Antioxidant, antibacterial, wound healing, haemostatic activities	Aqueous and ethanolic leaf extracts	Prove effective as antioxidant, antibacterial; having haemostatic activities
[2]	Obadoni, and Ochuko, 2002	Haemostatic activity	Ethanolic leaf extracts	Possess haemostatic activity
[3]	Inyang and Adegoke, 2008	Antibacterial activity	Ethanolic leaf extracts	Effective antibacterial agent
[4]	Douye et al., 2013	Antibacterial activity	Ethanol, crude and *aqueous* extract of leaf	Effective antibacterial agent
[5]	Suriyavathana and Parameswari, 2012	Antioxidant	Ethanolic leaf extracts	Natural antioxidant comparable to synthetic antioxidant
[6]	Mbajiuka et al., 2014	Antimirobial effects	Water and ethanol extracts of leaf	Antimicrobial effect on *Staphyloccocus aureus* and *E. coli*
[7]	Mbajiuka et al., 2014	*Antifungal effects*	Water and ethanol extracts of leaf	Potent antifungal effect on *Candida albicans*
[8]	Jagruti et al., 2014	Larvicidal activity	Methanolic leaf extract	Potential source of herbal larvicide for vector control
[9]	Jude and Catherine, 2011	Anti-cholesterolemic effect	Aqueous extract of leaf	Protective against the development of atherosclerosis and coronary heart disease.
[10]	Akomas and Ijioma, 2014	wound healing and management of bleeding problems	Ethanolic extracts of leaf	Reduction in bleeding and clotting times
[11]	Leonora et al., 2012	Immunopotentiating activities	Crude extract of leaf	Demonstrated the immunopotentiating activities on the innate immunity
[12]	Otarigho and Olajumoke, 2013	Molluscicidal activities	Aqueous and ethanolic leaf extracts	Active molluscicidal activity
[13]	Okwu et al., 2015	Antibacterial activity against Methicillin-resistant *Staphylococcus aureus* (MRSA)	Crude aqueous leaf extract	Active against MRSA isolates.
[14]	Udebuani et al., 2015	Anti-insecticidal property	Crude aqueous leaf extract	Potent insecticide

compounds. The people of different tribes and culture globally adapted traditional medicine as far back as time immemorial as sole medical system for health care before the advent of orthodox or modern medicine. Despite enormous improvement technologically, plant materials are successfully being used worldwide most especially among third world countries and still be the basis of development of modern drugs in advanced countries of the world (Edeoga et al., 2005). Some researchers (Obadoni and Ochuko, 2002; Nabavi et al., 2008; Anyasor et al., 2011) have concluded scientifically that *C. odorata* leaf could be a major sources of antioxidants, antimicrobials and phyto-constituents with therapeutic values. Natural antioxidants play important role in animal and human health by helping endogenous antioxidants to neutralize oxidative stress. Antioxidants inhibit or prevent oxidation of substrates and evolve to protect cells against the damage effects of reactive oxygen species (ROS), such as singlet oxygen, super oxide, hydroxyl radicals etc. An imbalance between antioxidants and ROS result in oxidative stress, which leads to the cellular damages (Gulcin, 2010). Iwu (1993) stated that *C. odorata* was useful in treatment of diarrhoea, spasmodic, hypertension and inflammation. It was also reported to be used traditionally for the treatment of burns, wound healing, skin infections, post-natal wounds, and antimalarial (Nurul et al., 2004). The decoctions of the flowers of *C. odorata* were used as tonic, antipyretic and heat tonic as stated by Buryapraphatsara and Chokcheijeroenporim, (2000). Ogbulie et al. (2004) reported the ability of the *C. odorata* extract to inhibit growth of the clinical bacterial isolates *in vitro* using the disc diffusion method, an indication of the presence of the bioactive compounds in the leaf that have antimicrobial action. This corroborated the earlier reports of several investigations that *C. odorata* flowering plants contain antimicrobial substances (Akujobi et al., 2004; Obafemi et al., 2006). Traditionally, fresh leaves or a decoction of *C. odorata* have been used throughout many tropical countries for the treatment of leech bite, soft tissue wounds, burn wounds, skin infection and liver diseases (Alisi et al., 2011). Obadoni and Ochuko, (2002) pointed out that the *C. odorata* crude extracts arrested bleeding from fresh wounds by reducing clotting and whole blood coagulation time which are important indices of haemostatic activity and this was corroborated by Anyasor et al. (2011). Haemostasis involves the spontaneous arrest of bleeding from damaged blood vessels which is important for initiation of tissue repair processes and prevention of tissue death through haemorrhage therefore *C. odorata* could be an important plant in treatment of wound. The molluscicides effect of *C. odorata* had been equally established by Otarigho and Morenikeji (2013) in an experimental trial and it was concluded that the plant could reduce specific freshwater snail, *Biomphalaria pfeifferi* populations, intermediate host that transmit human schistosomiasis. This would play an important role in schistosomiasis control in third world endemic countries. Schistosomiasis poses a great threat to populations in different parts of the world.

The strains of *Staphylococcus aureus* and *Pseudomonas aeruginosa* that had shown resistance to many antibiotics include two powerful known drugs (Gentamycin and Floxapen) (Irvin et al., 1981) had their growth strongly inhibited by the extract of the leaf of *C. odorata* (Nweze et al., 2004; Ogueke et al., 2006). Douye et al. (2013) also reported the growth inhibition effect of *C. odorata* on clinical isolate of *S. typhi* and *E. coli* and concluded that the findings were in agreement with submission of Nurul et al. (2004) and Sukanya et al. (2011). The findings also correlate with the observation of previous workers that the *C. odorata* contain substances that are antimicrobial (Olukoya, 1986). More so, recent findings by Kigigha and Zige (2013) proved the antibacterial efficacy of *C. odorata* against *E. coli* and thus revealed the potency of the plant in the control of typhoid fever and *E. coli* associated diarrhoeal diseases. The use of *C. odorata* extracts to treat diseases has stood the test of time (Anwannil and Atta, 2006). *C. odorata* is a potential and promising plant that should be explored for the management of diseases caused by Methicillin-resistant *Staphylococcus aureus* (MRSA) (and perhaps some other drug-resistant microorganisms) (Okwu *et al.,* 2014) thereby a good agent for the synthesis of novel drugs for use in the treatment of MRSA infections. MRSA is a strain of the bacterium *Staphylococcus aureus* that had been characterized by multi-drug resistance to many antibiotics such as aminoglycosides, clindamycin, fluoroquinolones, macrolides, penicillins, tetracyclines etc. It can cause the same types of infections as *S. aureus* isolates such as skin and soft tissue infections including impetigo, folliculitis, furunculosis, cellulitis, abscesses and wound infections. MRSA infections have now become a major public health concern and its prevalence is increasing globally (Peng et al., 2010; Okwu et al., 2014). This observation is significant in the health care delivery system since it could be used as alternative to orthodox antibiotics in the treatment of microbial infections especially as these bacteria frequently develop resistance to known antibiotics.

Nutritional benefits of *Chromoleana odorata*

Green leafy vegetables have long been documented as the inexpensive and most plentiful, probable source of proteins since they have ability to produce amino acids from an extensive variety of limitless and freely existing prime resources such as water, carbon dioxide and atmospheric nitrogen (Fasuyi and Aletor, 2005). Many plant leaves and stems are edible to Man and animal most especially in fresh form and this has been source of energy and protein. However, the avoidance of *C. odorata*

by grazing animals might not be unrelated with the offensive odour that originates from the leaves whenever they are bruised by the grazing animals in their effort to munch them (Aro, 1990). Death of livestock as a result of eating *C. odorata* had been reported (Prasad *et al*., 2005) and also McFadyen (2004) explained that the death of some goats as a result of consumed *C. odorata* could be due to presence of the alkaloids in the plant flowers. The cases of death reported could be due to consumption of raw *C. odorata* that was not treated; an indication that level of anti-nutritional factor in the plant was high. Some researchers (Mensah et al., 2008; Aro et al., 2009) analysed *C. odorata* proximately and concluded that it could serve as a good source of energy, flavour, minerals, protein and dietary fibre that could contribute to the palatability hence used to supplement animal feed. Nwinuka et al. (2009) reported that analysis of the leaves of *C. odorata* showed protein content of 24.08 ± 0.08% and energy content of 220.20 kcal and more so leaves also constituted a rich source of mineral elements such as Ca, Na, K, Fe, Mn, Zn, Cu, P, and Mg. In a recent, proximate analysis of *C. odorata* carried out by Tiamiyu et al. (2019) of which the results is shown in Table 4, *C. odorata* was proved as a good source of crude protein.

It had been reported by Fasuyi et al. (2005) that the dietary inclusion of *C. odorata* leaf even up to 7.5% does not result in mortality among the birds however it was pointed out that inclusion level of 5% seemed to support a desirable health status as indicated in the haematological and biochemical parameters studied. Tiamiyu *et al.* (2019) also concluded that inclusion of up to 3% of *C. odorata* dried leaf powder in African Catfish (*Clarias gariepinus*) feed as additive did not result in mortality and haematological and biochemical parameters of treated animals analysed were within normal range. Nwokolo (1987) reported that comparison of *C. odorata* leaf meal with that of cassava in terms of mineral composition however revealed a higher nutritional potential for Siam weed leaf. The Nigeria populace is facing incessant clashes between Fulani herdsmen and farmers as a result of damaging of field crops by cattle when crop farms were invaded for grazing purpose. This invasive plant, *C. odorata* that grow anyhow and all the year round could be a source of replacement portion of livestock feed which could be fed to cattle in paddocks. However, the use of *C. odorata* as a feed resource for livestock may require much scientific research to guide against the toxicity that could arise as a result of consumption of this plant.

Usefulness of *Chromolaena odorata* in arable farming

Chromolaena odorata is considered as a beneficial fallow plant. Some researchers (Ikuenobe and Analiefo, 2003; Koutika et al., 2005a) considered it as perfect fallow plant as it met the expected properties of species for fallow plant such as ease of establishment, large biomass, fast decomposition rate, weed suppression. Dove (1986) considered *C. odorata* as a welcome fallow plant rather than a weed in some slash-and-burn systems. Ikuenobe and Analiefo (2003) argued that infestation of weeds was lower in plots cropped after *C. odorata* than in the modified natural bush fallow in Nigeria. *C. odorata* grows dense canopy cover in a short space of time and was able to suppress other plant growth. Koutika et al. (2005b) argued that *C. odorata* is a good fallow option in the humid forest zone according to soil acidity and nutrient concentrations, while Kanmegne et al. (1999) also argued that *C. odorata* led to an improvement of soil properties. In central-southern Cameroon, Kanmegne et al. (1999) showed that *C. odorata* had a beneficial effect on exchangeable potasium concentration on a sandy soil developed on granites and on a sandy clayey soil developed on gneiss, by comparing natural fallow dominated by *C. odorata* and fallow where *C. odorata* had been removed by hand.

Detriments

Chromolaena odorata is an aggressive pioneer shrub species, which is regarded as a very serious threat to agriculture and the environment in most invaded countries. The high productivity of light seeds allows the species to invade disturbed sites in a short period of time (Holm et al., 1977). The rapid spread of the weed is due to extensive seed production which is estimated to be 93,000-160,000 seeds/plant (Wilson, 1995). *C. odorata* regenerates and colonises equally as well through its roots or by high seed production and it is also well dispersed by wind (MacDonald and Frame, 1988). Nowadays, this shrub is widespread in subtropical and tropical areas all over the world due to its fast invasion or colonisation and its facility to regenerate; *C. odorata* is present in different agricultural systems of its native continent (MacFadyen and Skarratt, 1996). All these characteristics have caused many researchers to recognize *C. odorata* as a serious weed in countries where it grows (MacFadyen and Skarratt, 1996). In addition, *C. odorata* is considered as an alien invasive species which negatively impacts the forest in economic, ecological and environmental and social and health terms (Holm et al., 1977; Moore, 2004). It is also considered as a considerable threat to conservation and ecotourism, as it has first invaded natural area, reducing the biodiversity of grasslands, savannahs and forests (Matthews and Brand, 2004). *C. odorata* is a considerable problem in commercial tree plantations as it suppresses the growth of young pine and eucalypt trees and allows fire to penetrate deeper into plantations (Matthews, 2004; Matthews and Brand, 2004). It can also promote wildland fires (Moore, 2004). *C. odorata* may also cause skin problems and asthma in allergy-prone people.

Table 4. Proximate analysis of *Chromolaena odorata.*

Moisture (%)	Fiber (%)	Fat (%)	Protein (%)	Ash (%)	Carbohydrate (%)
9.26	15.28	3.56	18.86	11.76	41.28

CONCLUSION AND RECOMMENDATION

The significance of the review is to recognize this plant as two-edged sword, with great potentialities for both benefit and harm. The healing properties of medicinal plants are usually linked with the presence of the bioactive compounds otherwise called secondary metabolites and these differ from one plant to another. The review concluded that *C. odorata* possess some of these secondary metabolites which could be attributed to its medicinal and nutritional usefulness. The success of extract of this plant as antimicrobial agent that inhibits the growth of hardy pathogens is a major breakthrough since issue of drug resistance has become a major public health concern globally. This observation is significant in the health care delivery system. The effectiveness of *C. odorata* as antiviral agent can still be investigated in view of novel coronavirus 19 (covid-19) that is ravaging world as a plague. It might work alone or in synergy with other medicinal plants as antiviral agent. However, the proper examination of the plant especially in the area of toxicity needs to be monitored. Herbal medicines generally considered to be safe and consumers view them as natural. The mere fact that herbs are natural does not mean that they are harmless. The toxicity of any herb mixtures should be evaluated; the strength, ingredients and dosage should be regulated by the appropriate government agencies of individual countries. It is finally recommended that effort should be made to research more into *C. odorata* to harness its benefit in term of medicinal properties, livestock nutrition and agricultural benefits.

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CONFLICT OF INTEREST

The author declare no competing interest.

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