European Journal of Medicinal Plants

33(6): 44-62, 2022; Article no.EJMP.87319
ISSN: 2231-0894, NLM ID: 101583475

Review on the Ethnobotany, Phytochemical and Pharmacological Profile of *Senna occidentalis* L. (*Fabaceae*): Potential Application as Remedy in the Treatment of *Dysmenorrhea*

Alain S-P. Kabasele Kalombo [a], Florent Biduaya Mukeba [b,c*], Assumani Zabo Idrissa [d], Jean-Paul Nzambi Divengi [d], Patience Lunkondo Mbuyi [d], Jean-Pierre K. Kayembe [e,f] and David Dago N'Da [g]

[a] Department of Biology, Faculty of Sciences, Pedagogical University of Kananga, Kananga, Democratic Republic of Congo.
[b] Department of Geography, Geostrategy, Environment and Spatial Planning, Center of Research of Human Sciences, Kinshasa, Democratic Republic of the Congo.
[c] Department of Biology, Faculty of Science, National Pedagogical University, Kinshasa, Democratic Republic of the Congo.
[d] Research Unity of Pedagogy and Health, Interdisciplinary Research Center of the National Pedagogical University, Kinshasa, Democratic Republic of the Congo.
[e] Department of Chemistry, Faculty of Sciences, Pedagogical University of Kananga, Democratic Republic of Congo.
[f] Catalysis and Synthesis Research Group, Research Focus Area for Chemical Resource Beneficiation (CRB), North-West University, Potchefstroom 2522, South Africa.
[g] Pharmaceutical Chemistry, Center of Excellence, for Pharmaceutical Sciences, School of Pharmacy, Faculty of Health Science, North-West University, South Africa.

Authors' contributions

This work was carried out in collaboration between all authors. Authors AKK and J-P KK designed the study, wrote the methodology and wrote the first draft of the manuscript. Authors AKK, FBM, AZI, PLM, JPND, J-P KK, and DDN, managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJMP/2022/v33i630472

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/87319

Review Article

Received 09 March 2022
Accepted 19 May 2022
Published 28 May 2022

**Corresponding author: E-mail: florent.mukeba@upn.ac.cd;*

ABSTRACT

Senna occidentalis L. has been used in several traditional medicines against various diseases and this is based on its botanical, ethnopharmacology, and phytochemistry profiles. This powerful herb is recognized for its antibacterial, antifungal, antidiabetic, anticancer, antimutagenic, protective, and inflammatory hepatic activity. Multiple chemical compounds, including achrosine, aloe-emodin, emodin, anthraquinones, etc., have been isolated from this plant. The results of this bibliographic research thus presented in this review have demonstrated the ability of certain extracts from *S. occidentalis* L. to lower the lipid peroxide content, the activity of gamma-glutamyl transpeptidase and phospholipase A2 in exudates of the granuloma of cotton pellets, thus resulting in a reduced availability of arachidonic acid, an important precursor in the biosynthesis of prostaglandins, which are the only likely source and/or cause of dysmenorrhea. Thus, based on its phytochemical profile and its pharmacological properties, it is therefore suggested that *S. occidentalis* would be a potential and effective remedy in the treatment of *dysmenorrhea*.

Keywords: Senna occidentalis L.; ethnobotany; pharmacological properties; prostaglandins; dysmenorrhea.

1. INTRODUCTION

1.1 Background

Since ancient times, plants have been used by human beings for various needs including food, and health care. To date, the nature still providing a more reliable source of medicaments. Almost 40% of the drugs currently available are direct or indirect derivatives of natural plant precursors [1].

The use of herbal remedies and other materials is an integral part of African culture. Contrary to popular belief that medicinal plants usually have few side effects and better compatibility with the human body [2], acute or chronic toxicity may result from their use. However, traditional healers are not always aware of this toxicity. They often use medicinal plants in most cases, without a deep knowledge of their side effects, including their toxicities, whereas some plants may cause serious poisoning, especially those containing pyrrolizidine alkaloids.

Natural plants have been used traditionaly as medicines in the pharmacopeia, for decades. Most of the world's populations depend on indigenous plants therapies owing to their safety [3,4]. Many therapeutic agents derived from plants and used in modern medicine have been resourced from natural (products) plants [5]. Most these plants have a variety of phytopharmaceuticals chemicals, with so much important applications in the fields of agriculture, human and veterinary medicine. They play a major role in the development of new drugs for the treatment and prevention of several diseases [6]. Therefore, it is very important to have sufficient knowledge of herbs not only because of their widespread use but also because they have the potential to cause toxic reactions or to interact with other medicines. In traditional medicine, Cassia species are well known for their laxative and purgative properties, and for the treatment of skin diseases, and hepatoxicity.

The phytochemical study of medicinal plants can therefore contribute to the regulation of empirical use, consumption patterns, with scientifically proven efficacy, and optimal cultural acceptability. Worldwide, pharmacological studies on plant extracts, secondary metabolisms, active ingredients, or biomolecules have proven to be effective on parasite, larvae, etc. [7,8].

Based on an in-depth study of the literature, *S. occidentalis* L. has many potentials to be considered as a medicinal plant and useful for various diseases. Regarding the phytochemistry of this plant, it has been demonstrated according to a scientific approach that the plant should be used as a drug [4]. It is also important to note that the phytochemical and biological effectiveness of the plant depends mainly on its geographic origin. More research is needed to use phytochemical compounds in the pharmaceutical industry as a substitute for medicine [4].

1.2 Classification

Reign : *Plantae*
Clade: Angiosperms
Clade: True dicots
Clade: Nucleus of the true dicots
Clade: *Rosidae*
Clade: *Fabidae*
Order: *Fabales*
Family: *Fabaceae*
Subfamily: *Caesalpiniaceae*
Tribe: *Cassieae*
Subtribe: *Cassiinae*
Gender: *Senna*
Species: *Senna occidentalis* (L.) Link, 1829
Synonym: *Cassia occidentalis* (L.)
(http://www.theplantlist.org/tpl1.1/record/ild-1086)

1.3 Description

Senna occidentalis is an erect sub-shrub or herbaceous plant, short-lived perennial (sometimes annual), with foliage giving off a characteristic fetid odor, up to 2 meters tall, but generally lower (50 cm at 1 meter), with a taproot.

The leaves, alternate, glabrous, slightly pubescent on the underside, carried by a short petiole, are compound paripinnate and 10 to 15 cm long. They have 4 to 6 pairs of oval to elliptical leaflets, 3 to 8 cm long and 15 to 40 mm wide. At the base of the petiole, there are two narrow triangular stipules, 2 to 4 mm long, early deciduous.

The flowers, 1.5 to 3 cm in diameter, solitary or grouped in axillary clusters of 2 to 5 flowers at the end of the branches, have a calyx formed of 5 green, elliptical sepals, a corolla comprising 5 oval petals, free, yellow in colour, around 13 mm long, 10 unequal stamens, 6 of which are fertile (2 large and 4 small) and 4 staminodes, a linear, arcuate, glabrous ovary, bearing a recurved, hairy stigma.

The fruit is an oblong, slightly arched, flattened, septate pod, 10-15 cm long by 7-8 mm wide. The pod, beige when ripe, is ascending and swollen at the level of the seeds and opens along both edges. It contains 20 to 60 seeds arranged in a line and separated by a thin membrane. You can hear the seeds when shaking the pod. The oblong, flattened, brown seeds are 4 mm long and 3 mm wide.

1.4 Distribution and Habitat

The original range of *Senna occidentalis* is in tropical America from Mexico in the north to Argentina in the south. This area includes Central America and the Antilles, and in South America countries such as Brazil (Parana, Rio Grande do Sul, Santa Catarina), Venezuela, Guyana, Colombia, Ecuador, Uruguay and Paraguay.

The species is widely cultivated in tropical countries and has become naturalized in all continents: in Africa (from Libya to South Africa and from Senegal to Ethiopia), in temperate Asia (Saudi Arabia, Yemen, Iran, Iraq, Lebanon, China), in tropical Asia: Indian subcontinent, in Southeast Asia (Indonesia, Papua New Guinea, Solomon Islands, Cambodia, Laos, Thailand, Vietnam, Malaysia, Philippines, Singapore) , as well as in Australia and Oceania (Hawaii, Marshall Islands, Micronesia, Northern Mariana Islands, Palau, French Polynesia, Pitcairn, Fiji, Nauru, New Caledonia, Niue, Samoa, Tonga). The plant has also become naturalized in some states of the United States (Alabama, Arkansas, Florida, Georgia, Mississippi, North Carolina, South Carolina, Oklahoma, Tennessee, Texas, Virginia).

2. METHODOLOGY

In this study, the research was carried on the relevant literature on *Senna occidentalis*, a plant species traditionally used as a drug. Plant databases including plantlist, ScienceDirect, PubMed, Google Scholar, and Scopus, have been used to retrieve articles on *S. occidentalis* L., which is the scientific name of this plant. This species has been used as a keyword for research, as well as the terms Ethnobotany, Phytochemistry, Pharmacological Properties, Prostaglandins, and Dysmenorrhea.

The naturally isolated chemical structures of this plant, its present compounds were designed using the ChenBioDraw Ultra 12.0 software. Finally, the bibliographic references were processed using the bibliographic software "Mendeley".

3. ETHNOBOTANY

S. occidentalis (*Fabaceae*) is a plant used in traditional medicine, with significant medicinal values. This plant is known by various names: Sene Café, Casse fétide and Café noir. *S. occidentalis* grains germinate in all tropical, and subtropical regions, including the United States to the East, Africa, Asia, and Australia [9,10]. *S. occidentalis* is considered as common weed, found throughout India up to an altitude of 1500 m [11] from Jammu-Kashmir to Kanyakumari. It is used differently in traditional medicine [12-14]. Despite a large amount of *S. occidentalis* consumption by animals and humans, certain effects are observed due to the toxicity of the seeds and leaves of this plant [15-18]. *S. occidentalis* is widely consumed as a substitute for coffee by local populations of India [19].
In a study by Humphry and his collaborators [20], farmers consider *S. occidentalis* to be an inedible herb. These authors indicate that almost 93% of villagers protect the plant and do not subtract it from their fields when they are doing the binding [21]. *S. occidentalis* is called Ran-tarota by residents of the Nasik district of Maharastra (India). The inhabitants of this region use an infusion of a mixture of the roots of *S. occidentalis*, *Caesalpini sepiaria*, and *Azadirachta indica*, for the treatement of women having problems of white losses.

In Mali, a traditional recipe made up of three herbs is used in the fight against malaria, consisting of *S. occidentalis* leaves, Lippia knight leaves, and olerace Spilanthes capitules [22]. The decoction made on the basis of a mixture of *S. occidentalis* and black pepper is widely used against filariasis [23]. New-born babies are bathed from the 7th, 12th, and 21st days by the inhabitants of the hills of Malyagiri in particular the Tarla people of the district of Dhenkanal of Orissa (India), which use a decoction formed of 15 leaves of each plant species of *S. occidentalis*, *Glycosmis pentaphylla* and *Vitex negundo* to immunize newborns against skin diseases. *S. occidentalis* is used against constipation. In addition, its roots, leaves, and grains are used as a purgative [24].

Fig. 1. *Senna occidentalis* L. plant images Addapted from:
(https://www.google.co.za/search?q=cassia+occidentalis+plant&tbm=isch&source=iu&ictx=1&fir=kf4LQtFNeg0w_M%252Cx7ABujqIylM30M%252C_%253BHkpLuo7eGrTAmM%252CsIldhSMFnQ9SBM%252C_%253BOM8rL; visited on the 10/04/2022).

4. PHYTOCHEMISTRY

Fluorescence spectrophotometry data show that the plant is rich in minerals, in particular, Fe, Ca, K, Mn, Mg, Zn, Cu, Na, P, and S as indicated in (Table 1) [25-28].

Table 1. Mineral and potential composition of metals contained in *S. occidentalis* [27]

No.	Mineral composition	Quantity (%)
1	Fe	11.036
2	Ca	2.69
3	Mn	2.39
4	K	2.36
5	Mg	1.54
6	Zn	1.24
7	Cu	0.74
8	Na	0.58
9	P	0.54
10	S	0.29
11	Pb	< 0.005 ppm
12	Hg	< 0.005 ppm
13	Cd	< 0.005 ppm

S. occidentalis is very rich in Fe with 11.036%. Ca, Mn, and K represent respectively: 2.63, 2.39, 2.36% whereas other items are in a small percentage. From these data, it can be deduced that *S. occidentalis* has a high Fe content and can therefore be used in the treatment of anemia. Ca and P deficiency causes the classic bone symptoms associated with rickets, such as arched legs, struck knees, spine curvature, and pelvic and thoracic deformities. Mg plays an important role in the structure and function of the human body. Iron, Zn, Cu, and Mn play an important role in improving the antioxidant system. The positive impact of Zn supplementation on the growth of some stunted children and on the prevalence of certain childhood illnesses such as diarrhea. The deficiency of Zn is likely to be a major public health problem, particularly in developing countries. [25, 29].

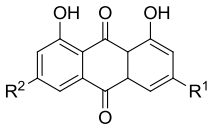
According to Food and Agriculture Organization (FAO), research has predicted that around 20% of the world population may be at risk of Zn deficiency with an average daily intake of < 70 mg/d [30]. These discoveries stimulate the culture of *S. occidentalis* on a large scale to relieve Fe and Zn deficiencies in the local community. The concentration of Pb in plant species is 2 to 6 mg/L [31].

Preliminary phytochemical analysis on an organic extract of *S. occidentalis* has revealed the presence of alkaloids, carbohydrates, flavonoids, phenolic compounds, tannins, and lignins [27], in the aerial part of *S. occidentalis* (Table 2) [27,32].

Flavonoids recorded a higher percentage of yield (2.45 mg/g) compared to alkaloids (1.56 mg/g), lignin (0.34 mg/g), tannins (0, 21 mg/g) and phenols (0.16 mg/g) per sample. The main chemicals content of *S. occidentalis* include achrosine, aloe-emodin, emodin [33], anthraquinones (Fig. 2), anthrones, apigenin, aurantiobtusine, campesterol, casseholline, chryso-obtusine., [34], islandicin, kaempferol, lignoceric acid, linoleic acid, linolenic acid, mannitol, mannopyranosyl, matteucinol, obtusifolin, obtusine, cioleic acid [35], physcion, rhamnosides, rhein, rubrofusarine, sitosterols, tannins, and xanthorine [34,35,36]. A study on *S. occidentalis* indicates that the nature and quantity of the phytochemical compounds of this species vary according to the climate. In Ivory Coast, for example, the stems, leaves, and bark of the roots of this plant contain a small number of saponins while there are no alkaloids, sterols, triterpenes, quinine, tannins, and flavonoids. On the contrary in Ethiopia, large quantities of alkaloids have been found in stems, leaves, and fruits [37].

Table 2. Major estimate of the Phytoconsstituents of *S. occidentalis* [27]

No.	Phytoconstitents of *S. occidentalis*	Quantity (mg/g)
1	Flavonoid	2.45
2	Alcaloid	1.56
3	Lignine	0.34
4	Tannin	0.21
5	Phenol	0.16



Name (trivial)	R^1	R^2
Rheine	CO_2H	H
Aloe-emodine	CH_2OH	H
Chrysophanol	CH_3	H
Emodine	CH_3	OH
Physcion	C_{H3}	OCH_3

Fig. 2. Structures of isolated compounds of Anthraquinones glycones of S. occidentalis [40]

Table 3. Nutritional value of *S. occidentalis* [27]

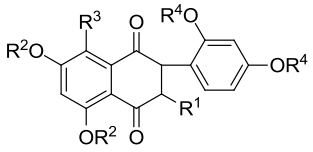
No.	Nutritional value	Quantity (mg/g)
1	Energy value	34.44
2	Raw fiber	5.69
3	Free amino acids	1.52
4	Carbohydrates	1.38
5	Proteins	0.49
6	Total fat	0.03
7	Cholesterol	0.03
8	Thiamine 6.9	0.0069
9	Niacin	0.0126
10	Riboflavin	0.0715
11	Catalase	0.0098
12	Lipase	0.0136
13	Amylase	0.0108
14	Alcaline Phosphatase	0.41
15	Phosphatase acid	10.8

S. occidentalis has been found to be a valuable source of dietary fiber in human food. The other nutritional constituents found are free amino acids and carbohydrates. Total fat and cholesterol levels are also low and represent only 0.03 mg/g. In addition to this, the plant is rich in vitamins, such as thiamine, niacin, and riboflavin, and enzymes, especially catalase, lipase, amylase, alkaline phosphatase, and acid phosphatase (Table 3) [25,27, 29]

Research has shown that *S. occidentalis* is very rich in energy with 34.44mg/g in a sample. Vitamins such as Niacin are more represented with 0.0126 mg/g [27].

4.1 Whole Plant

The 3,2-dihydroxy-7,8, 4-trimethoxy flavone-5-β-D-allopyranoside compounds (Fig. 3) were isolated throughout the plant from the ethanol extracts. Based on chemical evidence and the spectroscopic method, the chemical structures have been established. Three new flavonoids were isolated from the aerial part of the plant. These were C-glycosidics, Cassia occidentalines A, B, and C with 3-keto sugar [39].



1) R^1=R^4 = OH, R^3 = CH_3, R^4 = OCH_3
2) R^2= D-glucose, D-galactose,
3) R^1=R^2=R^4= D-allose sugar

Fig. 3. The isolated Phytochemical compounds of the Plante of *S. occidentalis*

4.2 Roots

In has been established by researchers that the roots of *S. occidentalis* may contaim about 1.9-4.5% of the free anthraquinones [33]. Emodine, 1,8-dihy-droxyanthraquinone, and flavonoid quercetin have also been identified. Samples of young roots were found without chrysophanol have also been reported in the roots of *S. occicentalis* [40]. Later, the sennosiolline which was also previouly identified but wrongly assigned, turned out to e be epinelin as established by Kudav et al., in 1947 [34]. However, Rheine's study revealed also the presence of 1,7-dihydroxy-3-méthyl xanthone [34,41].

In addition to pinseline [41], several 1,4, 5-trihydroxyanthraquinones from root samples such as islandicin, helminthosporin and xanthorine were extracted [35,42] and have shown that the roots contain rhein and aloe-emodine (both free) and glycosidic. Two new derivatives of bis (tetrahydro) anthracene, westernol-I (IV, R^1 = Me and R^2 = H) and westernol-II (III, R^1 = R^2 = H) and vitexin have been isolated (Fig. 3) from the roots of *S. occidentalis* with chrysophanol, emodin, pinseline, questine, gerylmichrysone. Spectral evidence served as the basis for establishing structures [43]. Two sterols called β-sitosterol and campesterol were found at the same time in the plant [44]. From the roots of *S. occidentalis* six anthraquinones including Islandicin, Chrysophanol, Physcion, Emodine, Questine, and 7-methyl-physcion, have been isolated. Also, bianthraqui-nones-chrysophanol 10,10-bianthrone), three tetrahydro anthracenes (Germichrysone, Methylgermitorosak) [45]., 2010) have been also isolated from thr roots of *S. occidentalis*. Researchers identified chrysophanol, rhein, emodin, and aloe-emodin in a sample from Nigeria [42].

4.3 Seeds

Research has demonstrated the presence of toxic albumin (whose identity is still unknown) and chrysophanol in the seeds of *S. occidentalis* (Fig. 5).

Later, the derivative of 1,4-oxazine N-methyl morpholine was prepared using samples of these grains of *S. occidentalis* [49]. Researhers have also repported the presence of heterosides of physciondianthrone and physcion condensed into homodianthrone as well as a mixture of anthraquinones [50], 1-glucoside of physcion (0.018%), physcion (0.0068%) from the seeds of *S. occidentalis*. In addition, two new anthraquinones, 1,8-dihydroxy-2-methyl anthraquinone, and 1,4,5-trihydroxy-3-methyl anthramethanox [35,44,51]in the form of aglycoside have been also isolated from the seeds of S. occidentalis [51,52].

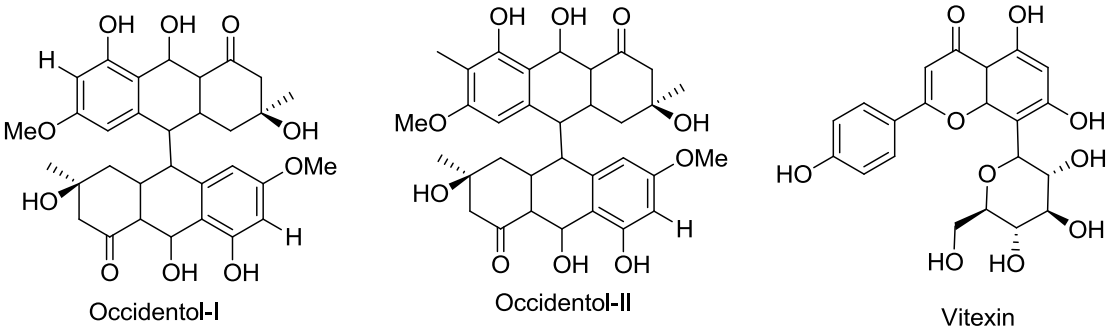


Fig. 4. The structures of Occidentol-I, II, and Vitexin, isolated from *S. occidentalis* [38]

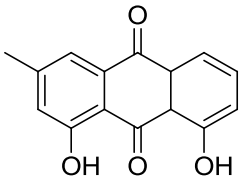


Fig. 5. Chemical structure of Chrysophano [46-48]

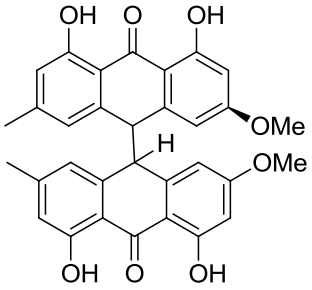


Fig. 6. Chemical structure of physciondianthrone (National institutes of health, national library of medicine, national center for biotechnology adapted from: https://pubchem.ncbi.nlm.gov/compound/physcion-10_10-bianthrone (accessed on the8 September 2021)

Valeri and Gimeno [53] identified resin, tannins, carbohydrates, and fatty acids in seeds. A new polysaccharide galactomannan molecule, composed of D-galactose and D-mannose in the proportion of 1: 3.1, as well as traces of D-xylose have also been found in the seeds of *S. occidentalis* [54,55]. From the seeds, carbohydrates (maltose, lactose, sucrose, and raffinose) were also detected [56]. There is also a report from Sudan, which indicates the presence of cardenolides, westernisare-1,8-dihydroxy-2-methyl anthraquinone, physcion, rhein, aloe-emodin, chrysophanol, and steroid glucosides in these grains [57,58]. A researcher in another study on *S. occidentalis* revealed that grains have an oil content of 3.2 to 45% fatty acids with a ratio of 2:20 (unsaturated/saturated). The total tocopherol content is 32.7 mg /100 g [59].

4.4 Leaves

The leaves of *S. occidentalis* have shown to contain a mixture of flavonoid C and apigenin (Fig. 7).

Next to these compounds, these authors found also vitexin, 7-vexin heteroside, chrysophanol, emodine, glycosides and as well as free physcion [42]. Bianthraquinone 1,1-bi-4,4 ′, 5,5′-tetrahydroxy-2,2′-dimethyl anthraquinone as well as flavone meterucinol-7-O-α-L-rhamnoside were also isolated from samples of f *S. occidentalis* leaves [60,61]. Other substances found in *S. occidentalis* leaves are alkaloids, flavonoids, tannins, phlobatannins, chrysophanol, emodine, physcion, tetrahydroanthracene derivatives, germichrysone and westernins A, B, and C. These compounds have been known to be potent anticancer [57]. Ethanolic and aqueous extracts from Nigerian's *S. occidentalis* leaves have shown the presence of alkaloids, tannins, saponins and phlobatannins [62].

4.5 Flowers

Chemical analysis of *S. occidentalis* flowers indicated the presence of anthraquinones, emodina, physcion, and physcion-1-O-β-D-glucoside as well as sterol β-sitosterol (Fig. 8) [63].

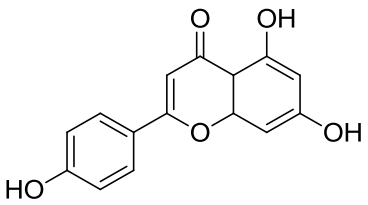


Fig. 7. Chemical structure of apigenin [46]

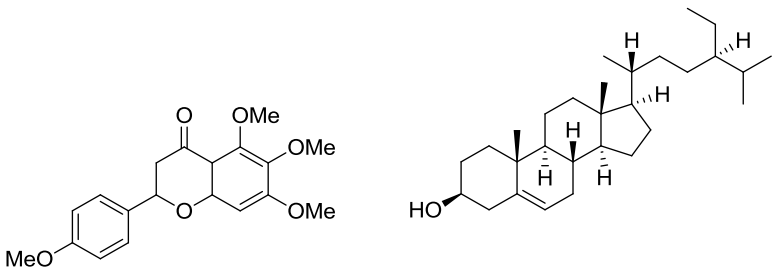


Fig. 8. The chemical structures of β-Sitosterol and Physcion-1-0-β-D-glucoside [46,64]

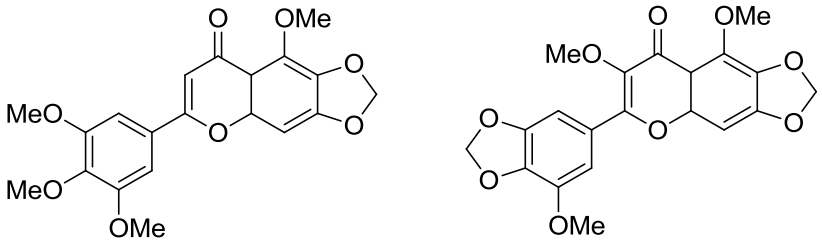


Fig. 9. Chemical structures of flavonoid A and B [46]

Two chemicals including the glycoside and two flavonoids **A** and **B** have been identified in the pods of *S. occidentalis* (Fig. 9).

Mailard identified the bioside as a neohesperidoside [65]. The two glycosides were found for the first time as natural products [66]. 1,8-Dihydroxy-2-methyl anthraquinone ; 1,4,5-trihydroxy-7-methoxy-3-methyl anthraquinone, physcion, rhein, aloe-emodine, chrysophanol and steroid glycosides have also been reported in *S. occidentalis* pods [57]. In China, literature data revealed that several glycosides have been isolated from flowers of *S. occidentalis*. These were identified as anthraquinone derivatives containing N-methylmorpholine, galactomannan, cassiolline, xanthorine, helminthosporin, apigenin, heteroside dianthrone, etc. [59].

5. PHARMACOLOGICAL PROPERTIES

The whole plant of *S. occidentalis* has been reported to be rich in important antibacterial, antifungal, laxative, analgesic, chlorinated and diuretic properties as presented in Table 4 [38,67].

Table 4. Ethnomedical values granted to *S. occidentalis* [38,67]

No.	Part of the plant used Ethnomedical use	Ethnomedicinal usage
1.	Whole plant	The extract of *S. occidentalis* has been used in traditional medicine to treat eye inflammation. In traditional Jamaican medicine, it is also used to treat diarrhea, dysentery, constipation, fever, cancer, eczema and venereal diseases [68].
2.	Roots	In veterinary medicine, the roots of *S. occidentalis* are used as a disease medicine in animals. They are also used as an antidote to neutralize the poison. The roots of this plant are also used to treat gastric disorders, increase lactation and fight against whooping cough [69]. In Nigeria, women use the decoction of *S. occidentalis* as herbal tea to fight against white losses [69]
3.	Leaves	The leaves *S. occidentalis* leaves are used to treat bone fractures, against fever, moth, skin diseases, throat infections and sores. Small branches of *S. occidentalis* are used as toothbrushes. The leaves of this plant are burned and the ash obtained is mixed with coconut oil. It is applied to the eyelids for a sweet sleep [70].
4.	Seeds	Grilled seeds are sprayed using a small amount of 3g equivalent to 1/10th of an ounce. To make tea, in China more precisely in Fujian province, the grains of the plant consumed in infusion replace tea for people suffering from high blood pressure. Blackberries are used on helminths and are used as antipyretics [7].
5.	Gousses	The Indians grill 8 to 10 pods of *S. occidentalis* and consume them against cough. They also use the decoction of grains and flowers, estimated at 10 g in the treatment of mental disorders [71].

5.1 Antimicrobial Activity

The chemicals products isolated from *S. occidentalis* leaves have shown activity against several types of microbes, including *Corynebacterium diphtheriae*, *Mucor sp.*, *Neisseria sp.*, *Salmonella sp*., and *Aspergillus niger* [26].

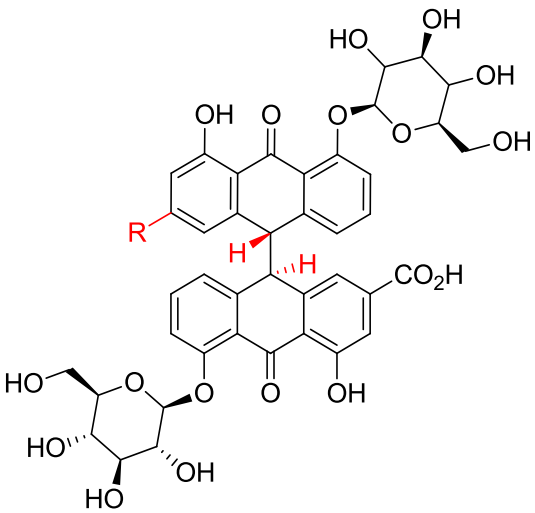
Tested against different pathogenic bacteria, the leaf extract of this plant has been shown to be active against *Salmonella enteridis* and *Staphylococcus aureus*. On the other hand, a negative effect was observed against *E. coli* and *Shigella dysenteriae* [72]. In another research, the extracts obtained from the leaves in different solvents proved a high antimicrobial action on *E. coli* in concentration between 900 and 1000 mg/L.

However, Sganuwan et al., 2006 repported that E. coli has been the most sensitive to the hexane extract of *S. occidentalis*, at concentrations between 500 and 1000 mg/L, whereas no antimicrobial activity was observed against other microorganisms tested on P. multocida, S. typhi, the S. typhimurium, S. pyogens and S. pneumoniae. Leaf extracts, flowers, pods and bark of *S. occidentalis* have been tested against different bacteria including P. aeruginosa, the B. cerus, the S. aureus, Proteus mirabilis and E. coli and on mushrooms (Candida albicans, Aspergillus niger, A. flavus and Fusariumoxysporum) [73].

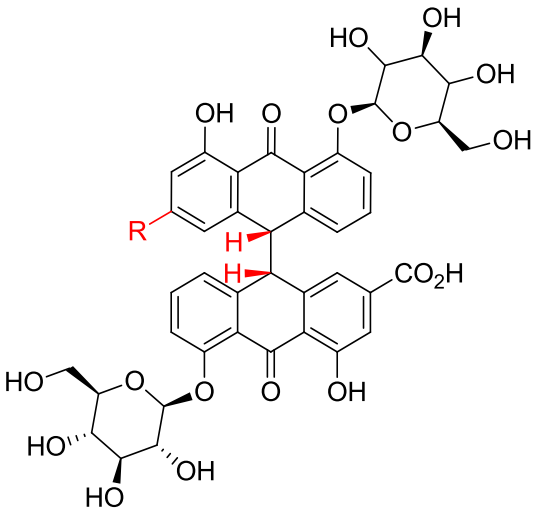
S. occidentallis plant extract has also demonstrated significant antimicrobial activities against all microorganisms comparable to ampicillin and gentamycin [74,75]. When the ethanol extract and the metabolite-rich fractions of different parts of *S. occidentalis* were examined, anthraquinones were observed to be more effective against E. coliand, S. aureus while the sennosides (Fig. 9) were more effective against *A. flavus* (28 mm) [74,75].

Furthermore, testing the antiviral and anti-tumor actions of *S. occidentallis*, revealed no activity of the extract [76]. The seeds of *S. occidentalis* have proven to possess strongly antibacterial activity against of *S. aureus*, *B. subtilis*, *B. proteus* and *Vibrio cholera* and antifungal action against *A. flavus*, *A. niger* and *Trichophyton mentagrophytes* [77-79].

It has been proven in a study on the antibacterial activity of *S. occidentalis* extract tested on microorganisms such as *S. aureus*, and *S. typhi*. It was established that these bacteria were sensitive to the *S. occidentalis* extract [65,80,81]. In another study on the antibacterial activity of plants used as drugs in traditional Ghanaian treatment with a particular reference to MRSA (Methicillin-resistant *S. aureus*), the action of *S. occidentalis* was reported. At the same time, other researchers found that *S. occidentalis* has significant antibacterial action [34,65].



Sennoside A: R = CO_2H
Sennoside C R = CH_2OH



Sennoside B: R = CO_2H
SennosideD R = CH_2OH

Fig. 10. The chemical structure of sennoglycosides [38]

The ethanolic and hot water extracts of *S. occidentalis* have been studied for their potential to release sodium and potassium ions against pathogenic bacteria selected in the genera *Bacillus subtilis*, *Staphylococcus*, *Escherichia*, *Streptococcus*, *Klebsiella*, *Pseudomonas* and *Salmonella* using the flame photometer. A researcher has proven the aqueous extract to be more effective against parasites in the leakage of Na and K ions, and while the ethanol extract demonstrated effectiveness against all organisms except Salmonella. In that study, the aqueous extract released 2.66 ppm of Na ions on *P. aeruginosa* whereas the ethanol extract did so with 13.3 ppm.

The mechanism of action of the antimicrobial activity of the *Fabaceae* family to which *S. occidentalis* belongs, can be explained by their ability to induce a leak of these ions [82]. Antimicrobial efficacy of *S. occidentalis* can cause damage and inactivation of enzymes due to their ability to induce leakage of these ions [83,84]. It has been established that Na and K ions are known to affect osmotic equilibria in the cell and their leakage can cause cell lilies and ultimately death. These ions are also known to activate enzymes which are biological catalysts and are involved in biochemical reactions [85].

Most cellular activities, including respiratory and biosynthetic functions, are under the control of enzymes.

S. occidentalis has been also used in formulation of several herbs [19]. This is the case with Liv.52, used as a tablet and syrup in the treatment of hepatitis A [19]. Moreover, several plants including *C. spinosa*, *C. intybus*, *S. nigrum, T. arjuna*, *A. folium* and *T. gallica* etc., and *S. occidentalis* have been in meta-analysis of 50 clinical studies over 30 years in 4490 patients [19]. The analysis was carried out to assess the short and long term efficacy and safety of Liv.52 in hepatitis A [19].

These authors concluded that Liv.52 tablets and syrups were very effective as the data revealed clinical and biochemical improvements with significant symptomatic control over this infection. In addition, a very significant reduction was noted during the average recovery period while no adverse reactions were reported in all trials and overall drug observance which resulted in better treatment of hepatitis A using *S. occidentalis* ofd [19].

5.2 Antioxidant and Hepato-protective Activities

The action of liver protection using organic and ethanol extract (50% v/v) of *S. occidentalis* leaves was led by Jafri and collaborators [86] on rat liver damage, induced by paracetamol and ethyl alcohol by monitoring serum transaminases, alkaline phosphatase, serum cholesterol, serum total lipids and histopathological alterations. It was concluded or just noted based on which analysis? or all above? that the leaf extract resulted in significant liver protection [86].

A few reports have shown that extracts from *S. occidentalis* reduced DNA degradation caused by the iron-induced fenton (II) reaction whereas Jafri and co-workers also reported that inhibition and DNA damage might be due to their high chelation capacity of ferrous ions [86,87].

Himoliv is a formulation used in traditional herbal treatment in which *S. occidentalis* is used as an ingredient at 20 mg / 5ml. It was suggested that Himoliv induces the prevention of hepatotoxicityinduced by carbon tetrachloride in rats [87]. Additonally, the formulation tended to decrease the final products of lipid peroxidation or MDA in the liver of rats that were bred in carbon tetrachloride. Another observation was that Himoliv improved the protective enzymes superoxide dismutase (SOD) and catalase in the homogenate of rat liver [87].

5.3 Antimalarial Activity

Various extracts from *S. occidentalis* have mounted significant antimalarial activity [88-90]. The ethanolic extracts of lyophilized dichloromethane from the bark and root of *S. occidentalis* were evaluated for four days for their antimalarial activity in vivo in suppressive tests against *P. berghei Anka* in mice [89].

No toxic or fatal effects were observed in mice treated orally with any of the extracts in a single dose of 500 mg / kg body weight, or at the same dose administered twice a week for a month. However, at a dose of 200 mg/kg, all the ethanol and dichloromethane extracts from the bark and roots produced significant chemo-suppressions, greater than 60% on parasitemia when administered orally. Hence these excerpts from *S. occidentalis* were active. It is also observed that the lyophilized aqueous extract was less active than the ethanol extract counterpart [89],

while boththe ethanol and chloroformic extracts demonstrated good antimalarial activity. Tona and co-workers speculated that these extracts had prevented more than 60% parasitic growth at a concentration of 6 µg/ml [88] which was confirmed in their subsequent study [90].

5.4 Anti-inflammatory Activity

Using the carrageenan-induced paw edema test and cotton ball granuloma, Sadique and co-workers have shown that the isolated compounds of *S. occidentalis* leaves have proven good anti-inflammatory activity [91]. Their study uncovered that *S. occidentalis* was most active at a dose of 2000 mg/kg. Furthermore, these extracts presented with the ability to decrease the lipid peroxide level. Another finding of their study was that the activity of gamma-glutamyl transpeptidase and phospholipase A2 in exudates of the granuloma of cotton pellets resulted in reduced availability of arachidonic acid, a precursor to the biosynthesis of prostaglandins [91].

5.5 Antimutagenic / anticarcinogenic Activity

Kinase inhibitors of the proto-oncogene cellular-Sarcoma (c-Src or simply Sarc) family have been shown to be involved in many signal transduction pathways, modulated by oncogenes. A study by Chang et al*.,* [92] investigated the activity *S. occidentalis* (a Chinese anti-tumor medicinal plant) on Src. Tyrosine kinase Lck (p56lck) and found the plant to be quite active in this bioassay.

A subsequent study Sharma and co-workers reported that extracts from Senkot tablets made of ethanol concentrate solution of *S. occidentalis* was not active on the mutagen, while inhibiting the mutagenicity of benzopyrene, aflatoxin B1 and methyl methanesulfonate in the Ames histidine reversion test using the strains TA98 and TA100 tested on *S. typhimurium* [93]. The research also unravelled the extract of Senkot to completely inhibited the mutagenicity of the promotional agents resulting largely from an interaction with the metabolic process involved in the activation of procarcinogens. It has been reported also that the extract of *S. occidentalis* had previously been reported to be effective against the chromosomal aberrations produced by benzopyrene and cyclophosphamide in mice [93].

5.6 Other Activities

S. occidentalis has been one of the ingredients most used in the preparation of Herbolax, which is an herbal formulation commonly used in the treatment of constipation. The efficacy of herbolax has been proven on 30 subjects with all patients reported to have a smooth and effortless evacuation of the stool. No patient experienced purging, pinching or abdominal pain following the treatment. In addition, no subject complained of aqueous stools, weakness, lethargy or cramps, and no recurrence of constipation after 2 weeks was found [94]. It was concluded that *S. occidentalis* possessed stimulates immunity-stimulating activity.

Furthermore, a new indigenous metabolic patch or sypup for newborns and infants, called "Bonnisan" containing 0.5mg/5ml of *S. occidentalis* is marketed. In this composition, it was found that *S. occidentalis*, and others plants spices including *P. longum*, *E. cardamomum* etc., could help bringing immediate relief from the discomfort caused by the gastric wind [95].

6. TOXICOLOGICAL STUDIES

S. occidentalis has been found to have some toxic effects in animals, which were found mainly on skeletal muscles, liver, kidneys, and heart. In these intoxicated animals, the toxicity rate varied from 0.05% to 0.5% of body weight. Acute atrophy of the liver and muscles have mainly been observed in these animals thatreceived extracts from *S. occidentalis* [96,97].

Moreover, there have been reports on poisoning of chicken characterized by weight loss, weakness, diarrhea, hypothermia, sometimes ataxia, decubitus and death upon consumption of *S. occidentalis*. This was further confirmed by macroscopic lesions revealing pallor of the skeletal and cardiac muscles and congestion of the liver [48]. Other toxicity signs found in chickens included focal swelling, fragmentation, and necrosis of muscle fibers of the semi-tendinous muscle during histological sections [98].

Further toxicological studies on liver mitochondria in chicks treated from 3 to 4 weeks have shown phosphorylation, respiratory control, and lower levels in the use of oxygen [99]. The seeds of *S. occidentalis* have been shown to be toxic in pigs through the development of ataxia and other signs of neuromuscular dysfunction in 6 or 8 weeks. Other toxicological studies have shown lethargy, weakness, decubitus, depression and wasting in rats fed with 1%, 2% and 4% of grains of the above plant [15,100].

The experiments carried out on rabbits revealed trace of the toxic effects due to *S. occidentalis*. Histopathological examination of rabbits reported the heart and the liver as the most organs affected by myocardial necrosis and centrolobular degeneration. The study found a decrease in the action of cytochrome oxidase in glycogenolytic fibers. Thus, a degeneration of the muscles was confirmed by morphometric studies. In different parts of India, numerous epidemics of acute childhood illnesses with severe brain dysfunction (Japanese encephalitis) occur at various times. These ailments have been linked to the consumption of *S. occidentalis* seeds [17,101-103].

Poisoning due to *S. occidentalis* in children seemed to mainly affect three systems, the liver, skeletal muscles and the brain [18]. In addition, it has been shown that the leaves of plant *S. occidentalis* contain phytochemical compounds which can be toxic to humans. In a detailed study on shrimp brine exposed to the toxic methanolic and chloroformic extracts from *S. occidentalis* leaves, itw as revealed that these extracts were lethal with LC_{50} value as low as 0.995 µg/ml [104].

In a subsequent study, excerpts from *S. occidentalis* also showed lethality on shrimp brine with a LC_{50} value of more than 1000 µg/ml [105]. Other research on the aqueous leaf extract of this plant has been shown to contain hypoproteinemic effects and the levels of alanine amino transferase enzymes, aspartate aminotransferase and alkaline phosphatase were significantly high, which demonstrates that *S. occidentalis* could be slightly toxic as a decoction for liver diseases [106].

However, root, leaves and stems have been toxic to cattle only when consumed in large quantities. In rats, leaf toxicity was observed at a dose of 12.5 g/kg body weight [107]. Aragao and collaborators [108] studied the toxic and reproductive effects of *S. occidentalis* extract on pregnant rats. In this study, three groups of pregnant rats were treated orally from the 1st to the 6th day (pre-implantation period) and from the 7th to the 14th day (organogenic period) of pregnancy, with doses of 250 and 500 mg/Kg. It was concluded, *S. occidentalis* extract was embryotoxic at the two doses of 250 and 500 mg/kg of C which was evidenced by the presence of dead fetuses.

Furtherstudies on the reproductive toxicity of ethanol extract in Derrisbrevipes and Justicia simplexin rats, revealed this extract to possess more abortive type effect than the anti-implantation activity. It also had low estrogenic activity in female albino rats [109].

7. DYSMENORRHEA

Dysmenorrhea is a real public health problem [110]. It affects 40 to 90% of adolescent girls and is a common cause of truancy. Despite the impact on their quality of life, only 15% of adolescent girls consult for dysmenorrhea [111,112]. Its prevalence among adolescent girls is estimated at 73% [113]. Dysmenorrhea implies the pain that occurs before or accompanies the rules in women. These pains are located mainly around the pelvis and can produce various signs such as headache, digestion disorders, inflammation of the uterine mucosa, etc. By manifesting themselves, pain can make someone lose their rights in society by disrupting the socio-economic dimensions of women [110]. Irritability and dizziness characterize women during dysmenorrhea [111].

Classically, the pains of dysmenorrhea begin in the early hours that mark the announcement of the rules and persist for two to three days [111]. Researches have established that these prostaglandins are the likely sources of pain experienced by women when developing primary dysmenorrhea [114]. It has been shown that prostaglandins activate the decrease in volume of uterus muscle [114].

In the event of high progesterone production, this inhibits the action of prostaglandins in order to cause the decrease in the volume of the uterus muscles. Excessive progesterone production decreases rapidly during menstruation and the production of prostaglandins increases. This causes the uterus to contract and cause the mucous membrane to be removed from the uterus.

This can lead to headaches, diarrhea, constipation, nausea and increased need for urine [114]. Prostaglandins cause the calcium found in the cell to rise resulting in an increase in uterine contraction [110]. As result of the dysmenorrhea pain or menstratuation produces, some women in sub-Saharan Africa practice self-medication in their habits to alleviate the pain. Inaccessibility and unafforbility to modern drugs intended to block the production of prostaglandins [114], push some women mostly in the developing countries to rather seek for

alternatives including the use medicinal plants including *S. occidentalis*, which is an excellent source (remedy) of value in order to treat dysmenorrhea. Thus, 25% of modern anti-dysmenorrhea drugs have been prepared from medicinal plants such as *S. occidentalis* and so many others that have been used in the traditional way [110].

8. CONCLUSION

The purpose of this study was to review the literature on the use, nutritional value, phytochemistry and phytopharmacological activities of this precious plant species, with a view to broadening its spectrum of use in the treatment of dysmenorrhea specifically. This has fortunately been demonstrated and proven by its good anti-inflammatory activity, as established by Sadique and co-workers in their study as described above (section 5.4 of this review). Their conclusions demonstrated the ability of extracts from this plant to lower the lipid peroxide content, the activity of gamma-glutamyl transpeptidase and phospholipase A2 in exudates of the granuloma of cotton pellets, resulting in a reduced availability of arachidonic acid, which is a major precursor to the biosynthesis of prostaglandins, which are a likely source and/or cause of dysmenorrhea. Thus, from all of the above mentioned, this research speculates that the plant *S. occidentalis* constitutes a potentially excellent remedy and a primary asset in the search for drugs against dysmenorrhea and other inflammations. It's therefore believed herein that the information presented and detailed in this review on the phytochemical profile and the pharmacological activities of the various extracts of the plant *S. occidentalis* provide, not only a detailed but also firm evidence on the use of this plant in different therapies including the treatement of the dysmenorrhea.

This study therefore, opens up new doors in this field specially, for future work, not only to improve the currently used therapies, but also to design and develop novel therapies, which are saffer, natural, and with less side effects than the previously or currently used synthetic pharmaceutical drugs, which are prepared in laboratories using long methodologies, toxic solvents and catalysts, with a high environmental risk and mostly in very poor yields.

- To the best of our knowledge, none of the research group published this topic as a review article.
- This research covered almost all reports, with a detail of the phytochemistry and phytopharmaceutical profiles and respective mode of action of some of them.
- This research strongly believes and anticipate that the summarized literatures in this field will definitely serve as an important update on *S. occidentalis* and its use, and permit researchers to also to develop novel drugs for different therapies, including the dismenorreah.

CONSENT

It's not applicable.

ETHICAL APPROVAL

It's not applicable.

ACKNOWLEDGEMENT

The authors highly acknowledge the support from the School of Pharmacy, Health Sciences, North-West University, Potchefstroom, South Africa and hereby declare no conflict of interest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sohail MN, Rasul F, Karim A, Kanwal U, Attitalla IH. Plant as a source of natural antiviral agents. Asian Journal of Animal and Veterinary Advances. 2011 Dec 1;6(12):1125-52.
2. Upadhyay HC, Saini DC, Srivastava SK. Phytochemical analysis of Ammannia multiflora. Research Journal of Phytochemistry. 2011;5(3):170-6.
3. Tagboto, S., Townson, S. (2001) Antiparasitic properties of medicinal plants and other naturally occurring products in Advances Parasitology, 50, 199-295p.
4. Gajalakshmi S, Vijayalakshmi S, Devi RV. Phytochemical and pharmacological properties of Annona muricata: a review. International Journal of Pharmacy and Pharmaceutical Sciences. 2012 Oct;4(2):3-6.
5. Oladunmoye MK, Adetuyi FC, Akinyosoye FA. Effect of Cassia hirsuta (L) extract on DNA profile of some microorganisms.

African Journal of Biotechnology. 2009;8(3).

6. Newman, D.J., Cragg, G.M., Snadder, K.M. (2003) Natural products as sources of new drugs over the period, 1981 – 2002 in Journal Nature Production, 66, 7, 1022 - 1037p.
7. Leaticia, N. *et al*. (2020). Phytochemical study of *Senna occidentalis* (L.) Link and *Cissus quadrangularis* (Linn) two Gabonese medicinal plants used against *Filaria loaloa* in introduction European Scientific Journal, 16, 21, p 10.
8. Lengani, A. *et al.* (2010). Traditional medicine and kidney diseases in Burkina Faso. In Nephrology and Therapeutics, 6, 1, 35-39p.
9. Liogier HA. Descriptive flora of Puerto Rico and adjacent islands, Spermatophyta. Vol. 2. Descriptive flora of Puerto Rico and adjacent islands, Spermatophyta. Vol. 2.. 1988.
10. Stevens, W.D., Ulloa-U, C., Pool, A., Monitel, O.H. (2001). Flora de Nicaragua. Monographs of Systematic Botany, St. Louis, MO in Missouri Botanical Garden Press, 85, 1-943p.
11. Khare CP. Indian Medicinal Plants: An Illustrated Dictionary Springer-Verlag. Berlin pg. 2007:699-700.
12. Kirtikar, K.R., Basu, B.D. (1933). Indian medicinal plant, Lalit Mohan Basu, Allahabad; 860–862p.
13. Nadkarni, A.K. (1976). Indian Materia Medica. Bombay, Popular publication; 289p.
14. Chopra, R.N., Nayar, S.L., Chopra, I.C. (1980). Glossary of Medicinal plants. NewDelhi: CSIR; 55p.
15. Barbosa-Ferreira M, Dagli ML, Maiorka PC, Górniak SL. Sub-acute intoxication by Senna occidentalis seeds in rats. Food and Chemical Toxicology. 2005 Apr 1;43(4):497-503.
16. Tasaka, A.C., Weg, R., Calore, E.E., Sinhorini, I.L., Dagli, M.L.Z., Haraguchi, M., *et al*. (2000). Toxicity testing of Senna occidentalis seed in rabbits. Veterinary Ressource Commun, 24, 573–582p.
17. Rao PN, Kumar PA, Rao TA, Prasad YA, Rao CJ, Rajyam L, Sarma MM, Ashok G. Role of Chandipura virus in an" epidemic brain attack" in Andhra Pradesh, India. Journal of Pediatric Neurology. 2004 Jan 1;2(3):131-43.
18. Vashishtha VM, Nayak NC, Jacob John T, Kumar A. Recurrent annual outbreaks of a hepato-myo-encephalopathy syndrome in children in western Uttar Pradesh, India. Indian Journal of Medical Research. 2007;125:523-33.
19. Kolhapure, S.A., Mitra, W.S. (2004). Meta-analysis of 50 phases III clinical trials inevaluation of efficacy and safety of Liv. 52 in infective hepatitis, 12, 51-61p.
20. Humphry CM, Clegg MS, Keen CL, Grivetti LE. Food diversity and drought survival. The Hausa example. International Journal of Food Sciences and Nutrition. 1993 Jan 1;44(1):1-6.
21. Pieroni, A., Price, L. (2006). Eating and Healing: Traditional Food as Medicine.Binghamton, New-York: Haworth Press; 24 pp.
22. Bodeker G, Burford G, Kronenberg F, editors. Traditional, complementary and alternative medicine: policy and public health perspectives. World Scientific; 2006 Dec 29.
23. Kumar, A., Nehar, S. (2007). Environmental Protection. New Delhi, Daya books, 157 p.
24. Warrier, P.K., Nambiar, V.P.K. (1994). Indian Medicinal Plants: A Compendium of 500 Species, Orient Blackswan, 2, 21p.
25. Osendarp SJ, West CE, Black RE. The need for maternal zinc supplementation in developing countries: an unresolved issue. The journal of Nutrition. 2003 Mar 1;133(3):817S-27S.
26. Hussain, H.S.N., Deeni, Y.Y. (1991). Plants in Kano ethnomedicine: screening for antimicrobial activity and alkaloids in Indian Journal Pharmacognosy, 29, 51-56p.
27. Sambasivam, M., Vellingiri, V., Pemaiah, B. (2016). Physicochemical study and nutritional properties of the aerial parts of *Cassia occidentalis* in Journal of Food and Drug Analysis, 24, 1, 508-515p.
28. Panigrahi GK, Suthar MK, Verma N, Asthana S, Tripathi A, Gupta SK, Saxena JK, Raisuddin S, Das M. Investigation of the interaction of anthraquinones of Cassia occidentalis seeds with bovine serum albumin by molecular docking and spectroscopic analysis: Correlation to their in vitro cytotoxic potential. Food Research International. 2015 Nov 1;77:368-77.

29. Hussain J, Khan AL, Rehman N, Hamayun M, Shah T, Nisar M, Bano T, Shinwari ZK, Lee I. Proximate and nutrient analysis of selected vegetable species: A case study of Karak region, Pakistan. African journal of Biotechnology. 2009;8(12).
30. Holt, C., Brown, K.H. (2004). International Zinc Nutrition Consultative Group (IZINCG) assessment of the risk of zinc deficiency in populations and options for its control in Food Nutritional, 25, 94-103p.
31. Zakir, S., Sarwar, M., Allen, J., Khan, M.N., Butt, M.S. (2006). Variation in physicochemical characteristics of some cultivars of sweet potato Pak in Journal Botany, 38, 283-291p.
32. Wink M, Schimmer O. Modes of action of defensive secondary metabolites. Annual plant reviews. 1999;3:17-33.
33. Alves, A.C. (1965). Pharmacological study of the root of *Cassia occidentalis* in Analysis Faculty Pharmaceutical, 24, 65-119p.
34. Kudav, N.A., Kulkarni, A.B. (1974). Chemical investigation onCassia occidentalisII.Isolation of islandicin, helminthosporin, xanthorin and NMR spectralstudies of cassiollin and its derivatives in Indian Journal Chemistry, 12, 1042-1044p.
35. Anton, R., Duqenois, P. (1968) The uses of *Cassia* in tropical and subtropical countries examined according to some of the chemical constituents of these medicinal plants in Plantes Medical Phytotherapia, 2, 255-268p.
36. Chukwujekwu JC, Coombes PH, Mulholland DA, Van Staden J. Emodin, an antibacterial anthraquinone from the roots of Cassia occidentalis. South African Journal of Botany. 2006 May 1;72(2):295-7.
37. Smolenski, I.J., Silinis, H., Farnsworth, N.R. (1975). Alkaloid screening VI. Lloydia, 38, 225-256p.
38. Yadav, *et al*. (2010). *Senna occidentalis L.* : la revue sur le profil l'ethnobotanique, photochimique et pharmacologique in Fitoterapia, 81, 223-230p.
39. Hatano, T.S., Mizuta, S., Ito, H., Yoshida, T. (1999). C-glycosidic flavonoids from *Cassia occidentalis* in Phytochemistry, 52, 1379-1383p.
40. Ginde BS, Hosangadi BD, Kudav NA, Nayak KV, Kulkarni AB. Chemical investigation on Cassia occidentalis Linn. Part I. Isolation and structure of cassiollin, a new xanthone. Journal of the Chemical Society C: Organic. 1970(9):1285-9.
41. Wader, G.R., Kudav, N.A. (1987). Chemical investigation of *Cassia occidentalis* with special reference to isolation of xanthones from Cassia species in Indian Journal Chemistry, 26, 703p.
42. Rai, P.M., Shok, M. (1982). Anthracene derivatives in tissue cultures of *Cassia* species indigenous to Nigeria, plant tissue culture in Proc. Int. Cong. Plant tissue Cell Cult., 227-278p.
43. Kitanaka, S., Igarashi, H., Takido, M. (1985). Formation of pigments by the tissue culture of *Cassia occidentalis* in Chemisrty Pharmaceutical Bulletin, 33, 971-978p.
44. Lal, J., Gupta, P.C. (1973). Anthraquinone glycoside from the seeds of *Cassia occidentalis* in Experentia, 29, 141-144p.
45. Kitanaka S, Takido M. Two New Bitetrahydroanthracenes from Roots of Cassia occidentalis L. Chemical and pharmaceutical bulletin. 1989 Feb 25;37(2):511-2.
46. Ganapathi, N., Kesireddy, K.R., Jamaludin, M. (2014). The genus polygonum (polygonaceae): an ethnopharmacological and phytochemical perspectives review in International Journal of Pharmacy and Pharmaceutical Sciences, 2, 6, 21-41p.
47. Ryan, K.J., Ray, C.G., Kefha, B.J. (2004). Sherrie's Medical Microbiology 4th, 119–125p.
48. Bruere, P. (1728) Bemerkungen uber ein in ungebranntem Zustand giftigesk affessurrogat Cassia occidentalis, Chem. Zentralblatt I, 194p.
49. Hebert CD, Flory W, Seger C, Blanchard RE. Preliminary isolation of a myodegenerative toxic principle from Cassia occidentalis. American Journal of Veterinary Research. 1983 Jul 1;44(7):1370-4.
50. Kim, H.L., Camp, B.J., Grigsby, R.D. (1971). Isolation of N-methyl-morpholine from the seeds of *Cassia occidentalis* in Journal Agriculture Food Chemisrty, 19, 198-189p.
51. Lal, J., Gupta, P.C. (1973). Anthraquinone glycoside from the seeds of *Cassia occidentalis* in Experentia, Physcion and

phytosterol from the roots of *Cassia occidentalis* in Phytochemistry, 12, 186p.

52. Rai PP, Shok M. Anthraquinone glycosides from plant parts of Cassia occidentalis. Ind J Pharm Sci. 1983;45:87-.
53. Valeri, H., Gimeno, N.F. (1952). Preliminary phytochemical and toxicologicalinvestigations of the seeds of *Cassia occidentalis* in Review Medical Veterinary Parasitol, 11,121-155p.
54. Gupta, D.S., Mukherjee, S. (1973). Structure of a galactomannan from *Cassia occidentalis* in Indian Journal chemistry, 11, 1134-1137p.
55. Gupta, D.S., Mukherjee, S. (1975). Structure of galactomannan from *Cassia occidentalis* seeds. Isolation and structure elucidation of oligosaccharides in Indian Journal Chemistry, 13, 1152-1154p.
56. Kheir YE, Salih MH. Investigation of certain plants used in Sudanese folk medicine. Fitoterapia. 1980;51(3):143-7.
57. Daniel, M. (2005). Medicinal Plants: Chemistry and Properties. Scientific publishers, 175p.
58. Pant, R., Kapur, A.S. (1963). The soluble carbohydrates of some Indian legumes. Nature wissenschaften, 50, 95p.
59. Huang, K.C., Williams, W.H. (1999). The Pharmacology of Chinese Herbs, CRS Press, 84p.
60. Tiwar, R.D., Singh, J. (1977). Anthraquinone pigments from *Cassia occidentalis*. Planta Medical, 32, 375-377p.
61. Tiwar, R.D., Singh, J. (1977). Flavonoids from the leaves of *Cassia occidentalis* in Phytochemistry, 16,1107-1108p.
62. Ogunkunle, A.T.J., Ladejobi, T.A. (2006). Ethnobotanical and phytochemical studies on some species of Senna in Nigeria in African Journal Biotechnology, 5, 2020-2023p.
63. Niranjan, G.S., Gupta, D.S. (1973). Chemical constituents of the flowers of *Cassia occidentalis* in Planta Medical, 23, 298-289p.
64. Manga, M., *et al.* (2004), "*In Vivo* Anti-Inflammatory Activity of *Alchornea cordifolia* (Schmach. et Thonn) Müll. Arg. (Euphorbiaceae)," Journal of Ethnopharmacology, 3, 92, 209-214p.
65. Maillard JY. Bacterial target sites for biocide action. Journal of applied microbiology. 2002 Jan 1;92:16S-27S.
66. Neuwinger HD. African ethnobotany: poisons and drugs: chemistry, pharmacology, toxicology. Crc Press; 1996.Cowans, M.M. (1999). Plant materials as antimicrobial agents in Chemistry Medical Review, 12, 564-582p.
67. Payne-Jackson, A., Alleyne, M.C. (2004). Jamaican Folk Medicines: A Source of Healing. University of West Indies Press, 1-228p.
68. Jain, S.K.D. (1991). Dictionary of Indian Folk Medicine and Ethnobotany, Deep Publication, New Delhi, India; 25-78p.
69. Patil, M.V., Patil, D.A. (2006). Ethnobotany of Nasik District of Maharastra. NewDelhi: Daya books, 1-419p.
70. Hu, S. (2005). Food Plants of China, Chinese University Press, 1-844p.
71. Muanza, D.N., Dangala, N.L., Mpay, O. (1993). Zairean medicinal plants as diarrhea remedies and their antibacterial activities in African Study Monograph, 14, 53-63p.
72. Saganuwan, A.S., Gulumbe, M.L. (2006). Evaluation of *in vitro* antimicrobial activities and phytochemical constituents *of S. occidentalis.* Animal Ressource Internationl, 3, 566-569p.
73. Ali, MS, Azhar I, Amtul Z, Ahmad VU, Usmanghani K. (1999) Antimicrobial screening of some Caesalpiniaceae in Fitoterapia, 70, 299-304p.
74. Abo, K.A., Adeyemi, A.A., Jegede, I.A. (1998). Standardization and utilization ofherbal medicines: challenges of the 21st century. Proceedings of 1st International Workshop on Herbal Medicinal Products, Ibadan, Nigeria, 22-24p.
75. Jain, S.C., Sharma, R.A., Jain, R., Mittal, C. (1991). Antimicrobial screening of *S. occidentalis* in vivo and invitro. Phytotherapy research, 12, 3, 200-204p.
76. Gaind, K.N., Budhiraja, R.D., Kaul, R.N. (1966). Antibiotic activity of *S. occidentalis* L. in Indian Journal Pharmacolog., 28, 248-250p.
77. Shah, C.S., Quadry, S.M.J.S., Tripathi, M.P. (1968). Indian *Cassia* pecies II. Pharmacognostical and phytochemical studies on the leaves of C. Toraand *S. occidentalis* L. Indian Journal Pharmacy, 30, 282-286p.
78. Qadry JS, Zafar R. Tissue culture studies of some Cassia species [flavouring and perfume plants]. Planta Medica. 1978..

79. Dabai YU, Muhammad S. Antibacterial activity of some Nigerian medicinal plants. Science World Journal. 2008;3 (2).
80. Perez, C., Anesini, C. (1994). *In vitro* antibacterial activity of Argentine folk medicinal plants againstS. Typhi in Journal Ethnopharmacology,44, 41-46p.
81. Jawetz, E., Melnick, J., Adelberg, E.A. (1998). Medical Microbiology 23rd, édition McGraw-Hill Company, 2004, 764p.
82. Samy, R.P., Ignacimuthu, S. (2000). Antibacterial activity of some folklore medicinal plants used by tribals in Western Ghats of Indian Journal Ethnopharmacology, 69, 63-71p.
83. Conway, P. (2002). Tree Medicine, A Comprehensive Guide to Healing Power of Over 170 trees. London: Judy Piatkus Publishers, 26p
84. Oladunmoyem, M.K., Akinyosoye, F.A., Adetuyi, F.C. (2007). Comparative studies on the amount of protein, sodium and potassium ions released bymethanolic extracts from six Cassia species in Asian Journal Cell Biological, 2, 29-33p.
85. Jafri, M.A., Subhani, M.J., Javed, K., Singh, S. (1999). Hepatoprotective activity ofleaves of *Cassia occidentalis* against paracetamol and ethyl alcohol intoxification in rats in Journal Ethnopharmacol, 66, 355-361p.
86. Bhattacharyya, D., Mukherjee, R., Pandit, S., Das, N., Sur, T.K. (2003). Prevention of carbon tetrachloride induced hepatotoxicity in rats by Himoliv. A polyherbal formulation in Indian Journal Pharmacology, 35, 183-185p.
87. Tona, L., Ngimbi, N.P., Tsakala, M., Mesia, K., Cimanga, K., Apers, S., *et al*. (1999). Antimalarial activity of 20 crude extracts from nine African medicinal plants used in Kinshasa Congo in Journal Ethnopharmacol, 68, 193-203p.
88. Tona, L., Mesia, K., Ngimbi, N.P., Chrimwami, B., Ahoka, O., Cimanga, K., *et al*. (2001). Tropical Medical Parasitol, 95, 47-57p.
89. Tona L, Cimanga RK, Mesia K, Musuamba CT, De Bruyne T, Apers S, Hernans N, Van Miert S, Pieters L, Totté J, Vlietinck AJ. In vitro antiplasmodial activity of extracts and fractions from seven medicinal plants used in the Democratic Republic of Congo. Journal of ethnopharmacology. 2004 Jul 1;93(1):27-32.
90. Sadique J, Chandra T, Thenmozhi V, Elango V. Biochemical modes of action of Cassia occidentalis and Cardiospermum halicacabum in inflammation. Journal of ethnopharmacology. 1987 Mar 1;19(2):201-12.
91. Chang, C., Ashendel, C.L., Chan, T.C.K., Geahlen, R.L., Laughlin, M., Waters, D.J. (1999). Oncogene signal transduction inhibitors from Chinese medicinal plants in Pure Application Chemistry, 71, 1101–1104p.
92. Sharma, N., Trikha, P., Athar, M., Raisuddin, S. (2000). In vitro inhibition ofcarcinogen-induced mutagenicity by *Cassia occidentalis* and Emblicaofficinalis in Drug Chemical Toxicology, 23, 477-484p.
93. Reddy, K., Kulkarni, K.L. (2001). A clinical trial of Herbolax in constipation duringpost-operative period. Antiseptic, 7, 252-253p.
94. Dhurandhar, J., Bonnisan (1973). A metabolic corrective in gastro intestinal disorders of newborn. Probe, 2, 73-78p.
95. O'Hara, P.J., Pierce, K.R., Reid, W.K. (1969). Degenerative myopathy associated with ingestion of *Cassia occidentalis*: clinical and pathologic features of the experimentally induced disease in American Journal Veterinary Ressource, 30, 2173-2180p.
96. Martin, B.W., Terry, M.K., Bridges, C.H., Bailey, C.M. (1981). Toxicity of *Cassia occidentalis* in the horse in Veterinary Humanity Toxicology, 23, 416-417p.
97. Simpson, C.F., Damrona, B.L., Hahrms, R.H. (1971). Toxic myopath of chick's fed *Cassia occidentalis* seeds. Avian Disease, 15, 284-290p.
98. Graziano, M.T., Flory, W., Seger, C.L., Hebcrt, C.D. (1983). Effects of *Cassia occidentalis* extract in the domestic chicken in Journal Veterinary Ressource., 44, 1238-1244p.
99. Colvin, B.M., Harrison, L.R., Sangaster, L.T., Gosser, H.S. (1986). *Cassia occidentalis* toxicosis in growing pigs in Journal American Veterinary Medical Association, .189, 423–426p.
100. Vashishtha VM, Kumar A, John TJ, Nayak NC. Cassia occidentalis poisoning causes fatal coma in children in western Uttar Pradesh. Indian pediatrics. 2007 Jul 1;44(7):522.

101. John TJ. Outbreak of killer brain disease in children: mystery or missed diagnosis?. Indian pediatrics. 2003 Sep 1;40(9):863-9.
102. Balraj, V. (2003). Investigation of outbreaks in India. How good are we at it? Indian Pediatrics, 40, 933-938p.
103. Orech, F.O, Akenga, T., Ochora, J., Friis, H., Aagaard-Hansen, J.. Potentialtoxicity of some traditional leafy vegetables consumed in Nyang'omadivision, Western Kenya in Afr Journal Food Nutritional Sciences. 2005;13.
104. Adoum OA. Determination of toxicity effects of some savannah plants using brine shrimp test (BST) in International Journal Pure Application Science. 2008;2:1-5.
105. Nuhu AA., Aliyu R. Effects of *Cassia occidentalis* aqueous leaf extracton biochemical markers of tissue damage in rats in Tropical Journal Pharmacy Resssource. 2008;7:1137-1142.
106. Nwude N, Ibrahim MA. Plants used in traditional veterinary medical practice in Nigeria in Journal Veterinary Pharmacology, (1980). 3, 261-273p.
107. Aragão TP, Lyra MM, Silva MG, Andrade BA, Ferreira PA, Ortega LF, Da Silva SD, Da Silva JC, Fraga MC, Wanderley AG, Lafayette SS. Toxicological reproductive study of Cassia occidentalis L. in female Wistar rats. Journal of ethnopharmacology. 2009 May 4;123(1):163-6.
108. Wistar rats in Journal Ethnopharmacology, 1, 23,163-166p.
109. Badami S, Aneesh R, Sankar S, Sathishkumar MN, Suresh B, Rajan S. Antifertility activity of Derris brevipes variety coriacea. Journal of ethnopharmacology. 2003 Jan 1;84(1):99-104.
110. Mahaman, D.G.S. (2006). Study of two recipes used in the traditional treatment of dysmenorrhea, Pharmacy thesis, Bamako, 26p
111. Bidet, M., (2013). Adolescent dysmenorrhea in Reproductive Medicine, Gynecology and Endocrinology, 15, 4, 328-333 p.
112. Kouyate, Y.M. (2008). Dysmenorrhea in adolescents, epidemio-clinical and therapeutic study at the reference health center of commune II in the district of Bamako. About 300 cases, thesis, Faculty of Medicine of Pharmacy, University of Bamako, 19p
113. Blondel, V.P., (2014). Dysmenorrhea in adolescents: About a descriptive survey of 907 high school girls from the Rouen conurbation Thesis, Mixed Faculty of Medicine and Pharmacy, France, .57p.
114. Tortora, G.J., Grabowski, S.R. Principles of anatomy and physiology, 2nd edition, De Boeck, paris. 1994;1028-1029.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/87319