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Ethnobotanical, trado-medicinal uses, pharmacological investigations and chemical constituents of *Sphenostylis stenocarpa* (*ex. a. Rich*) harms seed. A review

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Abstract
Spenostylis stenocarpa popularly known as African yam bean is a neglected legume despite its nutritional potentials. The seeds are consumed in the southeastern parts of Nigeria either cooked as porridge or roasted as snacks. In traditional medicine, the powdered seeds are reported to be used in the management of high blood pressure diabetes, high cholesterol, stroke and induction of milk production in lactating women. The current review examines, in general terms, the botany, trado-medicinal, pharmacological potentials and chemical constituents of *S. stenocarpa* seeds. The information was sourced from scientific investigation dumped on goggle scholar, research gate, science direct and pubmed data base. The phytochemical constituents of the seed extract as reported include alkaloids, tannins, flavonoids, steroids, phenolics and fatty acid esters. Solvent extract of the seeds has been reported to possess good therapeutic potentials as antidiabetics, anti-inflammatory, antioxidant, hematological and hepato-renal activities. Additionally, there is need for thorough research on the standardization of the powder and extract of *S. stenocarpa* seeds for better therapeutic applications. Also, isolation and structure elucidation of the bioactive constituents which might be responsible for the observed pharmacological activities needs to be done. These documented scientific investigations have corroborated the trado-medicinal uses of *S. stenocarpa* seeds.

Keywords: *Spenostylis stenocarpa,* medicinal plant, African yam bean, phytocompounds, antidiabetics and antioxidants

Introduction
Medicinal plants have been used in traditional medicine for the primary healthcare of most communities in both the developing and underdeveloped countries. In some countries, medicinal plants are recommended as an alternative medicine [1] while in some, they are used as first-line therapies. Medicinal plants contain various secondary metabolites that can be used for its therapeutic properties and can be used as precursors for the synthesis of new drugs [2-3]. The most important of these secondary metabolites of medicinal plants are alkaloids, flavonoids, saponins, terpenoids, tannins, steroids and polyphenols [4-5]. Several researchers have carried out pharmacological investigations to substantiate the acclaimed therapeutic potentials of medicinal plants. Currently some drugs from medicinal plants are employed in the mainstream medicine for treatment of diseases. Outstanding among these are; artemisinin from Artemisia annua used in the treatment of malaria [6], vincristine and vinblastine isolated from Catharanthus roseus used in treatment of cancer [7], and silymarin isolated from Silybum marianum used to treat liver disorder [8]. Such proven therapeutic potentials of plant sources remedies have instigated scientist to search for plants with potentials in treatment and management of various other disease ravaging mankind. *Sphenostylis stenocarpa* (ex. A. Rich) Harms, (Family: Fabaceae) popularly known as African yam bean (AYB) in English, is an underutilized leguminous plant of West African origin.
Sphenostylis stenocarpa is a vigorously climbing herbaceous vine whose height can reach 1.5-3 metres or more depending on the height of the stakes and cultivar [9]. The crop produces many branches which also twine strongly on available stakes. The vegetative growing stage is noted with profound production of trifoliate leaves. The terminal leaflets could be up to 14 cm long and 5 cm broad. The pollen grains had tricolporate, fenestrate and scabrateexine. It was further noted that the pollen grain had three colpus which were characteristically large with window-like spaces lacking a tectum. The pollen grains were single reticulate, slightly rounded without sharp corners, the spinous cover was interrupted by three protuberances (germpores) in a fixed geometrical pattern [10]. The flower seems to exhibit self-pollination and flowers profusely in 100 to 150 days, producing

brightly-colored flowers, which may be pink, purple or greenish white. The peduncle can hold up to three or more pods. The woody pods containing 20 to 30 seeds, are up to 30 cm long and mature within 170 days. Thepods usually turn brown when matured having flat or raised margin on both-side. Most dried pods do dehisce along the dorsal and the ventral suture causing shattering and loss of seeds [11]. The shiny seeds can be of different colors: white, grey, cream, light or dark brown, purple and black. There appear to be a number of varieties according to seed colour [12]. The stem of the plant produces small underground tubers of various sizes and shapes.

Taxonomy Profile
Kingdom- Plantae
Subkingdom - Tracheobionta
Super division - Spermatophyta
Division - Magnoliophyta
Class - Magnoliopsida
Subclass - Rosidae
Order - Fabales
Family - Fabaceae
Sub family - Papilionoideae
Tribe - Phaseoleae
Sub tribe - Phaseolinae
Genus - Sphenostylis E. Meyer
Species - *Sphenostylis stenocarpa* (Hochst. Ex. A. Rich.) Harms [13].

Plant Identity: *Sphenostylis stenocarpa*
(Hochst. Ex. A. Rich.) Harms

Synonyms: *Sphenostylis ornata* A. Chev., *Sphenostylis congensis* A. Chev., *Dolichos stenocarpus* Hochst. Ex. A. Rich. and Sphenostylis *katangensis* (De Wild.)Harms,

Common Names: African yam bean (AYB)

Vernacular Names: 'Diegemtenguere' (Mali), 'Norouko' and'Roya' (Sudan), 'Kulege' and 'Kutreku' (Ghana)
In the southern Nigeria it is known based on locality and dialect as 'Ewe' (Ijesha, Osun state), 'Otiili' (Ekiti, Ekiti state), 'Ekulu' (Ipe-Akoko, Ondo state), 'Peu' (Ijebu, Ogun state),'Sunmunu' (Iseyin, Oyo state), 'Ihiehie'(Ishan, Edo state), 'Iye' (Estako, Edo state), 'Ahuma' (Tiv, Benue state), 'Nsama' (Efik-Ibibio, AkwaIbom and Cross River state) according to Edem *et al*. (1990)). 'Odudu' (Ngwu Uzuakoli, Abia State), 'Akidi' (Anambra), 'Okpodudu' (Imo States), 'Uzoaki' (Awgu, Aninri, Nkanu, Enugu State), 'Ijiriji' (, Udeni, Igboeze South Igboeze North, and Igbo-Etiti, Enugu State), 'Uzoaki' (Afikpo, Ohaozara, Ebonyi State), 'Azama' (Izzi, Ikwo and Ohaukwu Ebonyi State) [14-16].

Geographical Distribution
The *sphenostylis stenocarpa* stretch within the latitudes of 15ºNorth to 15º south and the longitudes of 15ºWest to 40º East of Africa [17-18]. The following geographical locations are area where *S. stenocarpa* is cultivated in Africa: Chad, Ethiopia, Kenya, Tanzania, Uganda, Burundi, Central African Republic, Zaire, Cote d'Ivoire, Ghana, Guinea, Mali, Niger, Nigeria, Togo, Angola, Malawi, Zambia and Zimbabwe) [19]. It is worthy of note that Nigeria and Ghana are major player in the cultivation of the legume among other countries in Africa. In Nigeria the cultivation extends from the southern states of Nigeria to the north of the country [17]. In Ghana the cultivation is localized around Nkwanta and Ho-West districts of the Volta region of Ghana [20-21].

Trado-Medicinal Uses
Sphenostylis stenocarpa is one of the unexploited legumes in Africa despite its great potentials as a food security crop. It is cultivated for both edible seeds and underground tubers but the cultivation for tubers is limited to most of East and Central Africa while the seeds are preferred in West Africa [22]. It is cultivated in Nigeria mainly for the seed. In southeastern Nigeria the seed serve as indigenous food with various menu prepared from the seed either cooked or roasted. In Abia state, the seeds are roasted and eaten as snacks or cooked as porrage or mixed with 'ugba' fermented (*Pentaclethra macrophylla* seed) and 'okporoko' (stockfish). This is a cherished food serve during festive event among communities in Abia state. In anambra state, it is cooked with yam and serve aspottage or made into flour and fried as balls. In Ebonyi State it is roasted or eaten as snack with palmkernel or cooked with yam or as thickener/condiment for soup. In Enugu State the seed is made into flour and used to prepare moin-moin or cooked as pottage mixedwith vegetables, fermented (*Pentaclethra macrophylla* seed), dried fish and served as delicacy on festiveevents. It is also roasted and eaten as snack withsoft palm kernel. It could be cooked with yam and served as pottage or made into flour and mixedwith maize flour to prepare foo-foo, and served with "okra" (lady's finger) soup [23].

In Ghana, it is also grown primarily for its dry seeds among NkwantaDistrict; the Konkombas mill the dry seeds into flour, which is processed into a paste with water and some condiments. This is then wrapped into plantain leaves and boiled and eaten as 'turbani'. The flour may also be mixed with cassava flour and cooked into a paste eaten with soups or sauces. The Chalas, another ethnic group in the Nkwanta District, boil the dry seeds for about three hours, replacing the water intermittently. The cooked beans are made into sauce and eaten with 'gari', a roasted cassava product. In the Avatime traditional area of the Ho West District, fresh mature seeds are added to soups as a protein supplement, while dry seeds are roasted and milled into flour, which is processed into sauces or soups with additional condiments for eating with various foods. The seeds are roast and eaten with maize. The mature green beans are also boiled in the pods and eaten [21] hence, serves as alternative food supplement in the diets of malnourished children in the tropics. In the southeast Nigeria, the seed is dried, roasted and ground for medicinal purpose. The powdered seed is use in the treatment of diabetics, high cholesterol, insomnia, and stroke. In addition, it induces lactation in mothers after child birth [24]. The seed possesses bioactive compounds, essential minerals and amino acids as well as high protein content [25] which is responsible for the claims in management of health challenges.

Pharmacological Investigations

Anti-Diabetic Activity

The anti-diabetic Activity of *Sphenostylis stenocarpa* Seed Milk Extract in Alloxan-induced Diabetes Rats has been studied [26]. The comparative results of the *Sphenostylis stenocarpa* seed milk extract and glibenclamide on oral glucose tolerance in non- diabetic rat administered 2 g/kg body weight of glucose and 100 mg/kg body weight of *Sphenostylis stenocarpa* seed milk extract showed significant decrease in blood glucose level 30 minutes from treatment compared to glucose level after 15 minutes of treatment, and also showed significant reduction in glucose after 45, 60, 90 and 120 minutes respectively compared to glucose level after 30 minutes of treatment. The authors concluded that seed milk extract of *Sphenostylis stenocarpa* significantly reduced blood glucose levels in alloxan-induced diabetes animals. The anti-diabetic effect of the methanolic seed extract of *S. stenocarpa* was evaluated on glucose loaded and alloxan-induced diabetic rats using acute and sub-acute treatments [27]. The seed extract at 600 mg/kg body weight produced significant reduction in blood glucose but not to hypoglycemic levels in the glucose loaded normoglycemic rats. In the alloxan induced diabetes tests (acute and sub-acute), the methanolic extract at doses of 200, 400 and 600 mg/kg, showed a significant and considerable hypoglycemic activity compared to control. At 600 mg/kg, the extract showed comparable glucose reduction with glibenclamide throughout treatment days till day 10. Also, a dose dependent effect was produced by the extract in all models. From this result the researchers substantiated the claims of the anti-diabetic activity of seeds of *Sphenostylis stenocarpa* in folkloric medicine.

Anti-Inflammatory Activity

The effect of methanol extract of toasted African Yam Bean seeds on *In vivo* and *In vitro* anti-inflammatory studies were investigated [28] The results showed membrane-stabilizing property, as it significantly reduced the levels of haemolysis of human red blood cells exposed to hypotonic solution at dose-dependent level of 0.06mg/ml, 0.125mg/ml, 0.25mg/ml, 0.5mg/ml, 1.0mg/ml compared to indomethacin 1.0mg/ml. *S. stenocarp* seed significantly inhibited albumin denaturation at dose dependent level compared to indomethacin. Also, significant reduction was noticed in oedema induced by the phlogistic agent in rats at a dose-dependent manner; 5%, 4% and 2% in 2 hours compared to indomethacin. These findings indicated that *S. stenocarpa* seed extract contains anti-inflammatory agent. More researches are however needed to isolate the specific anti-inflammatory active component of the extract.

Antioxidant Activity

The DPPH scavenging capacity of the phenolic compounds of raw dried and autoclaved samples of *S. stenocarpa* seed was investigated [29]. The results suggest that phenolic extracts from *S. stenocarpa* seed have DPPH antioxidant power and the ability to scavenge free radicals. Acidic 70% acetone was the most effective in the extraction of phenolic content. Extracts obtained from raw seeds registered higher DPPH radical-scavenging activity than both the dry- and wet-heat treated seed samples.

The antioxidant activity of six accessions of *Sphenostylis stenocarpa* seed (TSS-10, TSS-57, TSS-84, TSS-95, TSS-96 and TSS-11) was investigated [30]. The results showed that 70% acetone exhibited higher TPC and TFC yield than the aqueous extract. TSS-10 had the highest TPC, DPPH scavenging and reducing power while TSS-96 and TSS-57 had the highest TFC and TAC respectively for aqueous extracts. For the 70% acetone, TSS-84 had the highest TPC, TFC and reducing power while TSS-10 and TSS-96 had the highest DPPH and TAC. In conclusion this research has substantiated the antioxidant activity of *S. stenocarpa* seed. The antioxidant activity of *S. stenocarpa* seed protein hydrolysate, and its peptides fractions of different molecular sizes was evaluated using various antioxidant evaluation models [31]. The results indicated good DPPH scavenging activity with *S. stenocarpa* seed protein hyroslyate showing low activity and its fraction membrane showing higher DPPH scavenging activity, the superoxide scavenging activity of peptide fraction was moderate and lower for the *S. stenocarpa* seed protein hyroslyate, both showered lower hydroxyl radical scavenging activity., the metal chelating activity of both were significantly strong, the reducing power activity were significantly lower and both showed dose dependent inhibition of lipid peroxidation in the linoleic acid emulsion system. From these

findings, *S. stenocarpa* possess potential as a food source of antioxidant agent. The free radical scavenging activity of germinated and non-germinated *S. stenocarpa* was tested by measuring their ability to quench the DPPH radical [32] The results showed that germinated *S. stenocarpa* seed had the higher DPPH free radical scavenging ability (48.92 µg/ml) than non-germinated *S. stenocarpa* seed (31.11 µg/ml). The germinated *S. stenocarpa* seed extract given orally produced a significant reduction in LPO in liver (50.75%). An increase of (50.16%) in the level of GSH in liver tissue of hyperlipidemia diabetic rat was observed after administration of germinated *S. stenocarpa* seed extracts. In conclusion, germinated *S. stenocarpa* seed can serve as dietary supplement in reducing the complications usually resulting from oxidative stress in diabetes and hyperlipidemia.

Hematological and Hepato-Renal Activity

Anti-anemic effect of methanol seed extract of *Sphenostylis stenocarpa* in Wistar albino rats showed a significant increase in the packed cell volume (PCV), red blood cells (RBC) and haemoglobin concentrations of rats after the fourth day of treatment with the extract [33]. The increase was comparable with a standard commercial brand drug, Ranferon, used in the treatment of anemia. There was no significant difference in the packed cell volume (PCV), red blood cells (RBC) and haemoglobin concentrations of the rats after the 8th day of treatment. In another Study the effect of aqueous extract of the seed was investigated on the liver and kidney and the result showed a significant decrease in the urea and creatinine level in the serum and also there was no significant effect on the ALP and LDH activities of the experimental rats [34]. The result suggest that the seed could be a putative source of iron which is responsible for red blood cell formation indicating its potential use in management of anemic condition. The reduction in liver enzymes, urea and creatinine is indication that consumption of roasted or aqueous seed may be useful in hepato-renal diseases.

Phytochemical Composition

The phytochemical studies on the processed and unprocessed seeds of *S. stenocarpa* have been reported by different researchers [28, 32, 39]. The results indicated the presence of alkaloids, flavonoids, tannins, steroids, phenolics and fatty acids esters. The fatty acid ester present in methanol extract of *S. stenocarpa* as shown from the GCMS analysis includes alpha-D-glupyranoside, methyl, cyclopentaneundodecanoic acid, oxalic acid, monoamide, N-(2-fluorophenyl)-dodecylester, dodecanoic acid,but-3-enyl ester, Methoxyacetic acid, tetradecyl ester, 2-heptanol,4-methyl, 3-(prop-2-enoyloxy)dodecane. The documented reports on the mineral composition showed the presence of sodium, potassium, calcium in reasonable amount in both processed and unprocessed seed while iron, zinc, copper and magnesium were in low amount [35-36]. Also, the nutritional content indicated the presence of protein, amino acids, carbohydrate, lipids and fibers [37-38]. The proximate and nutritional composition of seed of *S. stenocarpa* as reported, rightly fall within the permissible level and comparable to other regular consumed legumes within the tropics. Due to the presence of these phytochemical constituents which have demonstrated antimicrobial, antidiabetic, antinflammatory, antioxidant and hepatoprotective activity. *S. stenocarpa* have potentials as functional food which could be a better alternative to synthetic drugs in treatment and management of such health challenges within the tropical region. Despite all the medicinal properties of the plant, no compound has been isolated. However, there is need to carry out further phytochemical analysis to isolate and characterize bioactive constituents of the seed of *S. stenocarpa.*

Conclusion

There is an increasing interest in phytomedicine due to the therapeutic effect of medicinal plants. This has resulted in more laboratory investigations into the pharmacological properties of the secondary metabolites of medicinal plants. Herbal drugs have gained international recognition through discovery of active chemical constituents of plants responsible for the observed pharmacological actions. *S. stenocarpa* can be considered as a multi-purpose plant seed having good potentials for development of both pharmaceuticals and nutriceuticals. The current information regarding the medicinal property may serve as a prelude to more extensive studies on *S. stenocarpa* to explore more of its therapeutic activity and isolate the bioactive compounds of the plant.

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