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PLANT REVIEW

Solanecio biafrae: An Underutilized Nutraceutically-Important African Indigenous Vegetable

Oluwakemi Adetutu Bello, Opeyemi Isaac Ayanda, Oluwadurotimi Samuel Aworunse, Babafemi Ibukun Olukanmi, Michael Olasunkanmi Soladoye[1], Edward Babatunde Esan[2], Olawole Odun Obembe

Department of Biological Sciences, Covenant University, Canaanland Ota, [2]Department of Basic Sciences, Babcock University, Ilishan-Remo, Ogun State, [1]Department of Biological Sciences, Environmental Biology Unit, Augustine University, Ilara Epe, Lagos State, Nigeria

ABSTRACT

Solanecio biafrae (Olive and Hierne) C. Jeffrey (1986) (Family: Asteraceae), has synonyms *Senecio biafrae* Olive and Hierne (1877) and *Crassocephalum biafrae* (Olive and Hierne) S. Moore (1912). It is a perennial standent, underutilized African indigenous medicinal vegetable. It was first reported and published in Flora of Tropical Africa. Its common names varied from Gnanvule in Cote d'Ivoire to Worowo/bologi in Nigeria. It has alternate, simple, succulent, petiolated, and exauriculate leaves. Its propagation is vegetative by rooting of cuttings. However, there is no report on its propagation by seed. It is ubiquitous in cocoa plots in Nigeria, especially southwest; due to deliberate protection for economic revenue, but this has little-uncoordinated cultivation indication. These deliberately protected few are exposed to contamination by a chemical used for protecting cocoa plants. It is highly nutritive and rich in protein. It is also medicinally important as a galactagogue and for treatment of diabetes, high blood pressure, and infertility. It has biological activity against *Staphylococcus aureus* and *Escherichia coli*. It also has traditional and cultural claims for initiation and rituals. Personal interviews and search of the available literature on *S. biafrae* in electronic peer-reviewed English journals using scientific databases such as Google Scholar, Science Direct, PubMed, Scopus, and Web of Science was employed.

Key words: African indigenous vegetable, galactagogue and infertility, *Solanecio biafrae,* worowo

INTRODUCTION

African indigenous leafy vegetables are herbaceous species that are either cultivated or randomly hunted and collected from the wild for human consumption of their leaves. They are usually capable of coping with harsh environments, which are unsuitable for some other crops, thereby providing sustainable productions.[1] Furthermore, they possess a variety of genetic bases, a feature that can be useful in finding new genotypes and/or genes that will adapt to climate change because most of them have not been intensively selected.[2] They have medicinal properties reserved for the sick and recuperation.[3] However, they are mainly obtained from the wild and sparingly available in the market.[4] In Nigeria and in many other African countries, vegetables are very abundant immediately after the rains but become scarce late in the rainy season and scarce in the dry season.[5,6] This makes most indigenous vegetables, severalfold more costly than the usually cultivated species. This paper reviews the nutraceutical properties of the *Solanecio biafrae* and aims at arousing the general interest of researchers.

PLANT DESCRIPTION

S. biafrae is a perennial scandent shrubby herb with the stem up to 3 m long in height, strongly branched; stem/branches are succulent and glabrous [Plate 1].[7] Leaves are alternate, simple or deeply pinnately lobed, more or less succulent and petiolate; stipules are absent; petiole is slender and glabrous, 0.8–5.5 cm long and exauriculate; blade is triangular-subhastate to hastate or sagittate, 2.2–9 cm × 1.3–6.2 cm, margin is remotely sinuate-paucidentate in lower; base is weakly cordate or subtruncate and shortly decurrent onto the petiole; apex is more or less attenuate, acute, apiculate, and glabrous. Capitula are discoid and numerous in terminal loose thyrses of stalked congested subumbelliform corymbs; stalk of the individual capitula is short, shortly sparsely pubescent; involuncre cylindrical, 7–10 mm × 2–4 mm; bracts of calyculus 2–6, lax, glabrous, 6.5–10 mm long. Flowers are bisexual, tubular, pentamerous; disc florets are pale yellow; corolla is 6–8.5 mm long, tube glabrous, slightly expanded from above the middle, lobes 1.2–1.5 mm long, ovaries are glabrous. Achene is 3 mm long, ribbed and glabrous, black when ripe, with 6–8 mm long pappus.[8-11]

TAXONOMICAL CLASSIFICATION

S. biafrae belong to Kingdom (*Plantae*), division (*Tracheophyta*), class (*Magnoliopsida*), subclass (Magnoliidae), superorder (Asteranae), order (*Asterales*), family (*Asteraceae*), subfamily (*Asteroideae*), tribe (*Senecioneae*), subtribe (Senecioninae), genus (*Solanecio*), and species (*S. biafrae* (Olive and Hierne) (C. Jeffrey).[11-13]

NOMENCLATURE

The plant was first published as *Senecio biafrae* Olive and Heirne (1877) in Floral of Tropical Africa by Oliver, D. and Hierne, W. P. It was later

Correspondence:
Prof. Olawole Odun Obembe,
Department of Biological Sciences, Covenant University, Canaanland Ota, Ogun State, Nigeria.
E-mail: olawole.obembe@covenantuniversity.edu.ng

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delimited as *Crassocephalum biafrae* (Olive and Heirne) S. Moore (1912) and *S. biafrae* (Olive and Heirne) C. Jeffrey (1986). Common/vernacular names and the countries are listed in Table 1.

DISTRIBUTIONS

S. biafrae occurs naturally in African forest zones:[9] Upper Guinea, Uganda, Zaire, Nigeria, Liberia, Ghana, Sierra Leone, Ivory Coast, Congo, and from the Cameroons mountains.[8-11,16] It grows in large numbers as undercover in tree crop plantation, for example, cocoa[17,18] and kola (information from personal interviews) due to its requirement for shade and support. Its ubiquity in cocoa plots (Southwest Nigeria: - Osun, Ekiti, and Oyo States) was reported to be due to the deliberate protection and little-uncoordinated cultivation[18] due to its culinary importance as a potherb.[16] The study carried out by Awodoyin *et al.*[18] revealed that low relative importance value (RIV) of this vegetable growing in cocoa plots in Cross River State, Nigeria is attributed to harvesting without a concerted effort at replacing and no deliberate cultivation of the plant. Meanwhile, high RIV recorded in southwest Nigeria is ascribed to the efforts of the farmers in sparing stands of *S. biafrae* during weed control and deliberate introduction of some stands through propagation by cuttings to increase the stock. A low RIV was reported in plots where no use was known for *S. biafrae* resulting in the farmers not having cause to spare its stands during weed control.

Plate 1: (a) Branch of *Solanecio biafrae*[7]. (b) *Solanecio biafrae* (Bush)

Table 1: Common/vernacular names of *Solanecio biafrae* by country/region

Common names	Country/region	References
Gnanvule	Eastern Cote d'Ivoire (Anyi-Ndenye)	[14]
Yankonfeh	Ghana (Akan-Fante)	[9]
Kokolé titi	Ivory Coast (Kru-Guere)	[9]
Balo dédé	Ivory Coast (Nekedie)	[9]
Doua	Cameroon: Baham (Ghomala'a)	[15]
Ota eke	Nigeria: Igbo (Owerri)	[9]
Akọ amùnimúyè; g-bologi; worowo	Nigeria: Yoruba	[9]
Boludo	Nigeria: Yoruba (Ijebu-Ibefun)	Information from series of interview
Molepo/Malepo	Nigeria: Yoruba (Ode-Aye)	Information from series of interview
Rọrọwọ	Nigeria: Yoruba (Ilorin)	[9]
Lambe	Sierra Leone (Kissi, Krio)	[9,10]
pundo (English spinach)		
Bɔlɔgi	Sierra Leone (Krio)	
Worowo	Tanzania	[10]

PHYSIOLOGIC AND AGRONOMIC CHALLENGES

The spread of *Adenia cissampeloides* (a schiophyte), which is an exotic weed and the frequent use of herbicidal weed control in the cocoa plots have been threating *S. biafrae* population, which may result in the loss of the pharmacological/culinary service and functions of the species.[18]

PROPAGATION

S. biafrae is propagated vegetatively from vines for ages.[19,20] The stem and branches sourced from the vegetable markets are defoliated for food; and the stem thrown away at the backyards readily root (personal interview). Even though it can also be cultivated from seed,[21] this is done with great uncertainty and very rare. The previous report regarding its propagation via seeds reveals, two limiting factors, namely, poor seed viability (generally <2%) and difficulty in processing the seeds.[16] There has been no study on the seed yield and improvement.[16] Adebooye[22] attempted to propagate *S. biafrae* using 4–6 node cuttings that was 10–30 cm long while Sakpere *et al.*[21] propagated it using cuttings with two and three nodes that were 2–12 cm long and reported that it was adequate for the vegetative propagation of *S. biafrae*. It is an easy material, even in the water-hydroponic system (personal finding). There is, therefore, the need for more research to overcome the other limiting factors to its propagation, which will enable widespread cultivation of this vegetable. These may include trials on *in vitro* micropropagation, hydroponics, and mist system propagation.

INDIGENOUS KNOWLEDGE AND SUSTAINABLE USE

S. biafrae provides nutritive and medicinal value mostly to persons beyond 45 years of age.[21] With a decline in the projected 48 years life expectancy, consequently decreasing the population of the older generation,[23] it is risky to allow older generations to die with their wealth of knowledge of the plant that is used for health, vitality and rejuvenation. Moreover, *S. biafrae* is being replaced by other vegetables that do not require support and shade, thus, becoming rare and making gathering for consumption difficult.[16]

ECONOMIC IMPORTANCE

There are 17 species in the genus *Solanecio*, all of which are confined to tropical Africa, Madagascar and Yemen.[24] The genus has been reported to contain species, which are utilized in traditional medicine. The tubers and aerial parts and the of *Solanecio tuberosus* are used to heal wounds and stomach disorder;[25] young leaves of *Solanecio mannii* when mixed with other leaves are used as an enema for treating epilepsy;[26] *Solanecio angulatus* gives instant relief from toothache, and it is used to treat dermal and gastrointestinal problems, liver disorders, and headache.[25,27-29] The genus has been reported to exhibit a range of bioactivities including antitrypanosomal and hepatoprotective activities.[30,31] Active compounds such as pyrrolizidines alkaloids[25] and androgenic steroids[24] have been characterized from the genus. However, more phytochemical bioactive reports are still being carried out to boost the economic qualities of the genus in Nigeria.[32]

Nutritional importance

S. biafrae is an edible weed like the waterleaf but more potent when prepared as spiced vegetable soups (personal interview). It has succulent

leaves and stems, which are eaten as vegetable in soup and prepared as concoction in indigenous galactagogue recipe.[4,9,33] The fresh leaves have 32.71% protein and ascorbic acid (51.98%).[34] Meanwhile, the dry leaves have 12.94% crude protein, 4.33% crude fat, 17.23% crude fiber, 9.43% moisture, 6.20% ash, and 49.87% carbohydrate.[33] Omoyeni *et al.*[35] stated that *S. biafrae* is a potential source of indispensable amino acid for consumers. The amino acid content is high and the dry weight of the leaves have total amino acids of 72.5 g/100 gcp; valine value is 4.10 g/100 gcp; isoleucine is 3.61 g/100 gcp, phenylalanine is 3.92 g/100 gcp and threonine is 3.44 g/100 gcp. Going by these results, it could be safe to say that if the vegetables are consumed in sufficient amount, it could contribute to meeting human nutritional needs while simultaneously combating diseases associated with malnutrition. They recommended *S. biafrae* as food supplement since they provide a relatively cheap protein source compared to animal proteins as Lioyd[36] opined that foods, which provide more than 12% of the calorific value from protein are good sources of protein.

Meanwhile, in a study to elucidate some of the possible implications that could occur from consuming *S. biafrae*, Muhammed *et al.*[37] found that its aqueous extract administered orally had no harmful effects on the histological profile of the frontal cortex, liver, kidney, and testis of Sprague Dawley rats as a marker of toxicity. It was explained that the extract had no adverse and disruptive interference on cellular features of the organs.

Boiling reduced the anti-nutrient content of *S. biafrae* leaves appreciably such that the available nutrient can still be adequately utilized in the body.[38] Juicing of the vegetable for consumption was discouraged by the study conducted by Odufuwa *et al.*[39] when it was discovered that the oxalate content of the vegetable increased after juicing. Though, the leaf juice is usually applied to inflammation and not taken orally. Meanwhile, drying is employed to make sure that vegetables are available all year round. Therefore, Famurewa reported that drying at 50°C is adequate for the retention of the sensory characteristics of the plant.[34]

Medicinal/therapeutic importance

S. biafrae is used not only as food but also as cheap therapeutic agents for microbial gastroenteritis, some other medical and physiological disorders.[40,41] The phytochemical investigation we conducted to reveal the presence of tannins, saponins, flavonoids, alkaloids, anthocyanin and betacyanin, glycosides, terpenoids and coumarins (unpublished). Meanwhile, Ajiboye and Ojo[42] reported that *S. biafrae* has both hypoglycemic and anti-anemic properties because their findings showed that the aqueous leaf extract increases body weight and reduced glucose level. Its leaves contain various secondary metabolites such as dihydroisocoumarins, terpenoids, and sesquiterpenes.[16,17,43,44] It is used to treat cough and heart troubles.[45] It is also used as a tonic and as a rheumatic pain reliever as well as for prurient allergies and localized edemas.[45] In addition, it is used in the treatment of pile, hypertension, low sperm count, and dysentery.[46] It has an estrogenic effect and inductive potential.[47] Among the Yoruba speaking people in South West Nigeria, leaf extract of *S. biafrae* is used to stop bleeding from cuts or injury while it is used for the treatment of sore eyes in Sierra Leone and Cameroon.[4,48] The leaves are similarly widely used for the treatment of pulmonary defects, heart problem, cough, wound dressing, and rheumatism.[49,50]

Studies on the proximate composition of *S. biafrae* revealed that dry matter, ether extract and metabolizable energy contents were high. The leaves contain 90.80 mg/100 g Na, 2110.00 mg/100 g Ca, 0.75 mg/100 g Fe, 155.30 mg/100 g P, 574.00 mg/100 g K, 8.41 mg/100 g Zn, 1.89 mg/100 g Cu, 550.00 mg/100 g Mg and 3.20 mg/100 g Mn while the root contain 37.50 mg/100 g Na, 761.00 mg/100 g Ca, 1.83 mg/100 g Fe, 50.27 mg/100 g P, 495.00 mg/100 g K, 8.50 mg/100 g Zn, 3.72 mg/100 g Cu, 415.00 mg/100 g Mg, and 8.90 mg/100 g Mn.[33,51]

Galactagogue

S. biafrae is a botanical galactagogue in Nigeria.[33] The leaves are prepared as concoction and eaten as a vegetable in soup[33] while the pulped leaves are applied to the breasts as galactagogue in Cote d'Ivoire.[45] *Eremurus himalaicus, Ficus racemosa, Holostemma ada-kodien, Cuminus cyminum and Nigella glandulifera* are also used by practitioners of traditional systems of medicines as galactagogue (to induce or enhance lactation in nursing mother) in various part of the world.[52-56]

Diabetes

S. biafrae's therapeutic virtue in the treatment of diabetes or pulmonary defects is known in Nigeria.[9,57,58] The root is used for treating diabetes.[58] Aqueous leaf extract of *S. biafrae* orally administered to diabetic rats reduced the serum total cholesterol, low-density lipoprotein (LDL), triglycerides (TG), and very LDL-cholesterol index, which showed that it can be very useful in the management of diabetes coupled with its cardioprotective potential.[59]

Infertility

S. biafrae is widely used by traditional healers in the western region of Cameroon for the treatment of female infertility.[15,50,60,61] *S. biafrae* has estrogen effect and inductive potential on the onset of puberty in immature female rats.[47] A study conducted among traditional healers in Baham subdivision, Cameroon, showed that the concoction was prepared by maceration in palm wine and administered twice daily during 30 days to the patient for infertility treatment.[47] In another ethnopharmacological survey conducted by Telefo *et al.*, *S. biafrae* was reported to have the highest frequency citation among the plants used for the treatment of female infertility in Baham, Cameroon. The study revealed that the leaf and shoot administered orally with varying solvents (water or palm wine) at different doses (2 glass cup/day or unlimited days) for varying durations (2 days, 7 days, 30 days, or 34 days), prepared either as decoction or maceration. The study also evinced that *S. biafrae* is equally used for painful menstruation and horn's gulps. It is usually used in association with *Eremomastax speciosa* and *Ageratum conyzoides*. The mixture of *S. biafrae* and *E. speciosa* was reported to have the ability to precisely act on the normalization of the menstrual cycle by inducing ovarian folliculogenesis[47] while *A. conyzoides* could help combat infections of the reproductive system.[15]

BIOLOGICAL ACTIVITY

Information on the biological activity of *S. biafrae* is very scarce. However, *Salmonella typhi, Escherichia coli* and *Staphylococcus aureus* were resistant to the leaves of *S. biafrae*[41] while Gbadamosi and Okolosi[33] reported that *E. coli* is sensitive to its ethanolic leaf extract but resistant to *Klebsiella pneumonia, Pseudomonas aeruginosa, Candida albicans, Streptococcus pyogenes*, and *S. aureus*. In addition, the ethanolic extract of the root was reported to have high activity against *S. aureus* and *E. coli*.[51]

CULTURAL CLAIMS

Interviews of marketers in personal survey exercises revealed that in practical traditional herbal medicine also known as conventional medicine practiced across the southern part of Nigeria, *S. biafrae* is prescribed, sold and used to treat, prevent, as well as cure diseases. The plant is also nutritionally acclaimed in the West African region as food and medicine. It is used both as special soap for body pains during pregnancy and nutritional soup.

Information gathered from series of an interview conducted revealed that *S. biafrae* is traditionally used for a cough with squeezed leaves extract mixed with palm oil as the recipe. Furthermore, the leaves are blended with pepper and prepared as soup (concoction) for treatment of stroke. For measles treatment, the leaves are squeezed and the extract mixed with palm oil; the mixture is then taken regularly and a portion used as cream to rub the body. Meanwhile, a mixture of squeezed leaves extract and salt is taken as drink for the treatment dysentery. It was also gathered that its consumption with snail water prevents enlargement of the prostate in men.

S. biafrae is reported to be used in Congo for cultural/tribal initiation and for funeral rituals while Yorubas in Nigeria associate it with rituals to ward off smallpox.[15] In addition, the leaves are used as a baby wash and the seeds used for the treatment of diarrhea.[62]

CONCLUSION

This review has emphasized the potentials of *S. biafrae* as a veritable source for diverse nutritional and therapeutic materials. The numerous importance and uses of *S. biafrae* present the vegetable as a very cheap nutritional and pharmacological resource readily produced, affordable and available to all ranks of the populace in diverse economics. This resource is presently threatened, however, by exotic weeds, risk of herbicidal weed control, produce harvesting without concerted effort to replace them and nondeliberate cultivation of the vegetable. This review article has attempted to highlight the importance of *S. biafrae* as a nutraceutically-important African indigenous plant. Consequently, efforts should be geared toward extensive research and application of plant tissue techniques for the production of the secondary metabolites present in the vegetable. There is also the need to encourage its cultivation through *in vitro* micropropagation, hydroponics, mist propagation systems and most importantly sophisticated polyethylene tent, high humidity greenhouse environments to enable its all-year-round availability.

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Conflicts of interest

There are no conflicts of interest.

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