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Pharmacological and biotechnological overview of *Sauropus androgynus* L. Merr.: an underexploited perennial shrub

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ABSTRACT

Sauropus androgynus L. Merr is an unexploited medicinal shrub under the family *Phyllanthaceae* known as a green multivitamin plant and used as a leafy vegetable. Many phytochemicals from the leaf extracts of *S. androgynus* act as antioxidant, anti-microbial, wound-healing, anti-inflammatory, anti-diabetic, and anti-obesity agents and can potentially enhance breast milk production. The leaf extracts of this shrub contain ascorbic acid, eugenol, gallic acid, caffeic acid, syringic acid, p-coumaric acid, sinapic acid, ferulic acid, and different types of flavonoids. These phytochemicals have oxidative scavenging, glucosidase inhibitory, and superoxide dismutase activities. The plant has several nutrients to help metabolic activity and increase longevity. Herbal industries depend on natural resources. Identifying plant species is also essential before using them as herbal ingredients. DNA barcoding tags are used to determine the authenticity of plant species and herbal drugs. Seven barcoding markers have been tested for the identification of *S. androgynus*. Markers rbcl, rpoC1, and trnH-psbA showed the fragment size at 580, 500, and 520 bp, respectively. However, rpoC1I and adh reflect at 380 and 300 bp and the ycf5 show at 450 bp. These markers may be used to authenticate the plant and prepare herbal medicine. This review highlighted the basic biology, phytochemical, pharmacological, and biotechnological overview of *S. androgynus* for sustainable human health.

1. INTRODUCTION

Sauropus androgynus L. Merr is a perennial shrub commonly known as Chekurmanis under the family Phyllanthaceae. It has various significant properties for the preparation of traditional medicines. It grows naturally in hot and humid climates, spreading over countries such as China, India, Sri Lanka, Vietnam, Indonesia, Malaysia, Papua New Guinea, Indonesia, Philippines, and Cambodia [1,2]. *S. androgynus* is a traditional herbal drug that alleviates fever [2,3] and cures vector-borne diseases [4]. The shrub is used for leafy vegetables in most of the tropical countries. Leaves are a galactagogue agent that stimulates lactate glands, enhancing and accelerating milk secretion in women [5]. Andarwulan et al. [6] reported that these shrubs have numerous medicinal values to cure diseases such as cholestasis, cough, ophthalmia, soreness, coryza, and erythrina. In addition, the stem and leaves of this shrub are used for treating hepatitis, laryngitis, and enteritis [7]. The root extract has been used to cure ailments such as dysentery, tuberculosis, and scabies [8]. Countries such as Taiwan and Malaysia have been used to control hypertension, gall bladder stones, hyperlipidemia, urolithiasis, and various gynecological disorders [9,10]. Padmavathi and Rao [1] noted that the shrub has also been named "multigreen" because of its high in vitamins A, B1, B2, and C, provitamin A, carbohydrate, protein, Ca, Zn, Fe, Cu, K, P, and α-tocopherol [11], and other bioactive compounds such as alkaloids, tannins, saponins, and flavonoids that are used as antibacterial agents as well as antioxidants [12]. Traditionally, this plant was more used by humans because its leaves were high in vitamin C and phenolic compounds [2]. It is reported that the vitamin content in the dry leaf deepened the age of the plant's growth and development [13]. Mature leaf tissues have more vitamin and nutrient content than young leaves. The genetic diversity among the plants grown in different regions was analyzed using inter-simple sequence repeat (ISSR) markers [14]. The authenticity of the plant species using DNA barcoding tags helps to conserve the plants in nature. D'Souza et al. [15] used zinc oxide nanoparticles (ZnOSA NPs) derived from leaf extract of *S. androgynus* (SA) having sizes ranging from 12 to 23 nm for cancer

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therapy. They observed that ZnOSA NPs showed higher frequency anticancer properties against human triple-negative breast cancer cells. These nanoparticles have superior photocatalytic activity and high strength. Sagna et al. [16] reported that the hydroalcoholic leaf extract of *S. androgynus* exhibited ethnomedicinal activity and reduced the expression of the viral protein of the Chikungunya virus. Therefore, this review highlighted the biology, traditional ethnomedicinal knowledge, and biotechnological overview of the plant in human usefulness. It can help promote plant conservation and provide an opportunity to validate the medicinal use.

2. DESCRIPTION AND HIGHLIGHTS OF THE PLANT MORPHOLOGY AND ITS CHARACTERISTICS

Sauropus androgynus is known as "multigreen" due to its high vitamin and nutrient content, and this leafy vegetable is usually consumed raw in salad, stir-fried, used in curry, or cooked in soups in most countries in Southeast Asia. It grows abundantly in high-humidity locations. The branches are angular, and the leaves are pinnately compound. Flowers are dark red, and fruits are light yellow in color and globular in shape [17]. It has been reported that various communities in different countries use this shrub because of its nutritional and ethnomedicinal characteristics. *S. androgynus* is a valuable source of bioaccessibility of nutrients (Figure 1), food fortification, ethnomedicinal, and antioxidant characteristics. *S. androgynus* helps to increase lactation in women in Indonesia and Malaysia [10,18]. Furthermore, Thai people traditionally use the roots of this plant to reduce fever, treat food poisoning, and act as an antiseptic agent [19,20]. This plant has significant potential as a slimming agent to combat obesity. In India, the leaves are used as antidiabetic and to improve vision. Bhaskar et al. [21] reported that these shrubs have various antimicrobial properties, promote wound repair, and treat blurred vision and tonsillitis. It has also been reported as an antidiabetic aid [22]. The dark green leaves have various nutritional values and are used for human consumption in Southeast Asia. The leaves of *S. androgynus* are effective as an antioxidant [6,23]. Joshi et al. [24] identified 12 compounds abundantly distributed in *S. androgynus* leaves. The high percentage of the compounds is squalene (36.9%), vitamin E (12.5%), and linolenic acid (10.2%). The significant phytochemicals are camphor, borneol, 4-terpineol, 8-cymenol, α-terpineol, carvacrol methyl ether, carve one, sabinene hydrate acetate, thymol, α-terpinene acetate, carvacrol, butylated hydroxytoluene, cedrol, quercetin, kaempferol, and β-carotene [25]. It also acts as an antiviral and protective function on infected organs [25]. Linoleic acid treatment directly interacts with the white spot syndrome virus and inhibits the virus from entering cells and viral replication in the shrimp's intestine [26,27]. Kaempferol showed significant inhibition against the Japanese encephalitis virus [28]. It contains many substances, such as sterols, resins, tannins, saponins, alkaloids, flavonoids, terpenoids, glycosides, and phenols [Tables 1A and 1B].

3. *IN VITRO* CLONAL PROPAGATION OF *S. ANDROGYNUS*

Generally, *S. androgynus* is propagated by either seed or stem cuttings. However, seed propagation is relatively low. Quality planting materials are necessary for propagation. The authenticity of planting material is of utmost importance when preparing plant products. Eganathan and Parida [34] established the *in vitro* protocol for large-scale propagation of *S. androgynus* using nodal culture. The nodes were inoculated on Murashige and Skoog's (MS) [35] medium along with different

Table 1A: Phytochemical constituents in methanolic extract of *S. androgynus* stem.

Name of the Major Compounds Present	Percent Present	References
9, 12, 15-octadecatrienoic acid, ethyl ester (Z, Z, Z)	14.48%	Fikri et al. [29]
Phytol	13.08%	
Glycerin	2.52%	
1-Methyl-2-pyrrolidineethanol	2.27%	
Acetic acid	1.81%	
Pent-1-en-3-one,1-(2-furyl)-5-dimeth-ylamino	1.69%	
Benzofuran, 2,3-dihydro	1.65%	
2-Acetylpyrrolidine	1.51%	
4-*O*-methylmannose	1.46%	
N-Ethyl-2-carbomethoxyazetidine	1.43%	
9-Ethoxy-10-oxatricyclo [7.2.1.0 (1, 6)] dodecan-11-one	1.36%	
1H-indole, 5-fluoro-	1.30%	
Hexadecanoic acid	1.18%	
Oleic acid	1.18%	
Heptaethylene glycol monododecyl ether	1.12%	
N, N-dimethyl-2-aminoethanol	1.05%	
2-Methoxy-4-vinylphenol	0.97%	
L-Phenylalanine	0.95%	
Pentaethylene glycol	0.95%	
4, 6-Di-*O*-methyl-α-D-galactose	0.94%	
Octadecanoic acid	0.85%	
Thiophene, tetrahydro-2-methyl	0.82%	
3-Hexanol, 2, 5-dimethyl	0.79%	
Phenol	0.76%	
Tetradecanoic acid	0.75%	
Benzophenone, 3-methoxy-4'-methyl	0.75%	
Ethylidenecycloheptane	0.75%	
β-Sitosterol	0.68%	
9, 12-Octadecadienoic acid, methyl ester (E, E)	0.63%	
2-Pyrrolidinone	0.50%	
Morpholine	0.48%	
N-Chloroacetyl-D-phenylalanine	0.47%	
1-Butanol, 2-ethyl	0.44%	
4, 6-Di-*O*-methyl-α-D-galactose	0.40%	

Table 1B: Phytochemical constituents present in leaf extract of *S. androgynus*.

Name of the Major Compound Present	Percent Present*	Percent Present**	References
(9E,12E,15E)-Octadeca9,12,15-trienal	36.98%	–	Sawasdee et al. [14]
γ-Sitosterol	0.98%	0.54%	
Squalene	9.66%	36.9%	
Palmitic acid	3.88%	4.77%	Sawasdee et al. [14]
δ-Tocopherol	–	15.26%	
	–	8.9%	Joshi et al. [24]
Phytol acetate	2.84%	–	Sawasdee et al. [14]
γ-Tocopherol	1.73%	5.80%	
	–	7.6%	Joshi et al. [24]

(Continued)

Table 1B: (Continued)

Name of the Major Compound Present	Percent Present*	Percent Present**	References
β-Tocopherol	–	1.86%	Sawasdee et al. [14]
	–	2.2%	Joshi et al. [24]
Lanosta-8,24-dien-3-ol	–	4.01%	Sawasdee et al. [14]
Lupenone	–	4.96%	
Hexadecanoic acid, ethyl ester	–	4.00%	
Hexadecanoic acid		5.6%	Joshi et al. [24]
3,7,11,15-Tetramethyl-2-hexadecen-1-ol	0.69%	–	Sawasdee et al. [14]
dl-α-Tocopherol	1.89%	–	
Lupeol acetate		1.03%	
Caryophyllene		1.00%	
Tetradecanoic acid	0.24%	–	
Tetradecanoic acid, ethyl ester		0.83%	
Hexadecanoic acid, methyl ester		0.48%	
Ethyl 4-ethoxybenzoate	0.44%	–	
1,1'-Methylene-bis(di-2-propenylamine)	0.20%	–	
β-Caryophyllene	–	0.1%	Joshi et al. [24]
Methyl hexadecanoate	–	0.5%	
Linolenic acid	–	10.2%	
Vit E		12.5%	
Phytonadione	–	0.7%	
Sesquiterpene hydrocarbon	–	0.1%	
Long-chain oxygenated hydrocarbons	–	16.3%	
Triterpenoids	–	42.8%	
Chromane terpenoids	–	31.2%	
Quinine terpenoid	–	0.7%	
(E)-β-Ionone	–	T	
Phenyl derivative		T	
β-Sitosterol		5.9%	
Neophytadiene	2.92%	–	Anju et al. [17] Selvi and Bhaskar [30]
Palmitic acid	48.73%	–	Anju et al. [17] Santoso and Fenita [31]
Myristic acid	8.81%	–	
Stearic acid	3.08%	–	
Oleic acid	6.72%	–	
Decanoic acid	0.57%	–	Anju et al. [17] Selvi and Bhaskar [30]
Phytol	13.08%	–	Anju et al. [17] Fikri et al. [29]
Squalene	8.06%	–	Anju et al. [17] Selvi and Bhaskar [30]
Solanesol	4.09%	–	Anju et al. [17] Kuttinath et al. [32]
Terpenoids	4.03%	–	Anju et al. [17] Awaludin et al. [33]
Linoleic acid	5.25%	–	
Phenolic compounds	15.3%	–	
Carotenoid	32%	–	

*Ethanol solvent used. **Hexane solvent used.

concentrations of 6-benzylaminopurine (BAP; 0.1–2.5 mg/l) and kinetin (0.01–0.25 mg/l). After 4 weeks of culture, the shoot proliferation was achieved on MS medium supplemented with 1.0 mg/l BAP and 0.1 mg/l kinetin. Root initiation from the excised *in vitro* shoots on ½ strength MS medium fortified with 0.5 mg/l indole-3-butyric acid and 0.25 mg/L α-napthaleneacetic acid. Wee et al. [36] reported the plant regeneration pathway of *S. androgynus* through an *in vitro* culture system. Plant tissue culture is an alternative step of propagation to overcome the limitations of conventional multiplication and ensure the sustainable production of quality plant material with desirable traits. They successfully grew shoots through liquid culture and achieved more advantages over semisolid growth mediums. Acclimatization and survival growth rates were higher in the natural environment.

4. MOLECULAR STUDY OF *S. ANDROGYNUS*

Widely cultivated *S. androgynus* is used for various traditional medicinal purposes. There are 27 *Sauropus* species used as vegetables and in conventional medicine [37]. All plant parts have different active properties such as nutritional, vitamins, antioxidant, antimicrobial, antiviral, and so on. Over 100 active metabolites were developed from leaves, shoots, and roots. Antiobesity properties were observed in the leaf extract of *S. androgynus*, which helps to reduce body weight. The selection of *S. androgynus* is based on phenotypical, biochemical, and phytochemical properties. However, these approaches are not specific to the authenticity of the plant species. Genetic variation occurs due to plants' adaptation to their environment and the passing of their genes onto subsequent generations. There are very close similarities in morphological points of view. Wide domestication resulted in botanical evolution and diversity, which caused significant changes in ITS sequences. Recently, DNA technology has been used to authenticate the plant species more accurately, which is a prerequisite for pharmaceutical and chemical investigation. PCR-based DNA technology has been used to identify plant species and herbal crude drugs [38-40]. Yunita et al. [41] reported the molecular study of intraspecific differences among *S. androgynus* (L.) Merr, which originated in Indonesia. They observed variability in the sequences of nuclear ribosomal DNA's internal transcribed spacer (ITS) regions. Sawasdee et al. [42] used ISSR primers to identify the genetic similarity between the *Sauropus* species and the close relative genus *Breynia* species. Based on the similarity index, the variation of similarity value was 0.71–0.81 between *Breynia* and *Sauropus*, 0.76–0.85 at the interspecific level of *Breynia,* and 0.69–0.80 in the *Sauropus* species. They also reported that the barcodes rpoB and *trn*H-*psb*A spacer regions help to identify the genus at the species level. Amplification of the DNA fragments in the rpoB and psbA-trnH spacer regions of the *Breynia* and *Sauropus* species showed sizes of 500 and 400 bp, respectively. With sequence alignments of the MEGA7, genetic distances of the two genera revealed that the distances were 0.000–0.008 at the intergeneric level, 0.000–0.008 between the interspecific *Sauropus* species in the rpoB region, 0.000–0.099 at the intergeneric level, and 0.000–0.120 between the interspecific *Sauropus* species in the psbA-trnH spacer region [42]. Rout and Swain (unpublished data) [43] used seven barcoding markers (rbcL, rpoc1,psbA-trnH, rpoc1, ycf5, adh, and matK) to distinguish and recognize the economic species to help in the conservation of natural resources [44]. Moreover, rbcL and matK are the most valuable genes for identifying genus and species levels [45]. Nowadays, methods for studying the identification of plants rely on nuclear and chloroplast genome sequencing because of the simple and stable genetic structure of the chloroplast and nuclear genome. The universal primers, such as rbcL, matK, and rpoC1, amplify these target sequences [Figure 2].

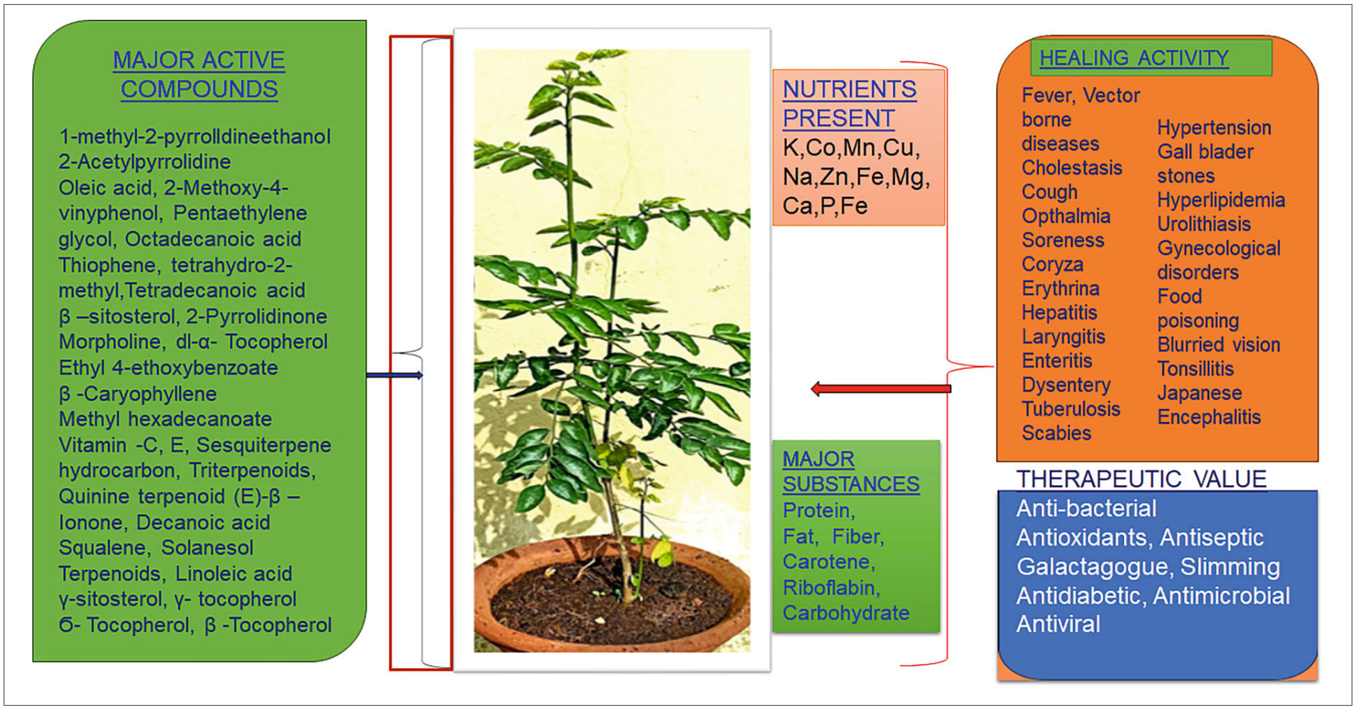

Figure 1: Salient features of *S. androgynus* L. Merr.

Table 2: DNA barcoding analysis of *S. androgynus* [43].

Barcoding Primers Used	Sequence (5'–3')	Annealing Temperature (^{O}C)	Fragment Size (bp)
rbcL	F:ATGTCACCACAAACAGAGACTAAAGC	55	580
	R:GTAAAATCAAGTCCACCRCG		
rpoC1	F2:GGCAAAGAGGGAAGATTTCG	55	500
	R4:CCATAAGCATATCTTGAGTTGG		
psbA-trnH	F:GTTATGCATGAACGTAATGCTC	56	520
	R:CGCGCATGGTGGATTCACAATCC		
rpoC1	F1:GTGGATACACTTCTTGATAATGG	55	380
	R3:TGAGAAAACATAAGTAAACGGGC		
ycf5	F1:GGATTATTAGTCACTCGTTGG	55	300
	R4:CCCAATACCATCATACTTAC		
adh	F:CACACCGACGTCTACTTCTG	52	560
	R:AGAGTGTTGGAGAGGGTGTGAC		
matK	F:ATGCAACACCCTGTTCTGAC	52	480
	R:TAATTAAGAGGATTCACCAG		

DNA fragment amplification in the rbcL,rpoC1, psbA-trnH, rpoC1, ycfs, adh, and matK spacer regions of the *S. androgynus* showed sizes of approximately 580, 500, 520, 380, 300, 450, and 560, respectively [Table 2]. The protein signature of *S. androgynus* is also illustrated in Figure 2. SDS-PAGE analysis indicates that seven leaf protein fragments emerge in *S. androgynus* ranging from 20.1 to 81.7 kDa.

5. NUTRIENT AND PHYTOCHEMICAL CONSTITUENTS

Sauropus androgynus is multigreen vegetables with high nutrient and vitamin content [46]. Padmavathi and Rao [1] reported that leaves contain about 7.4 g of protein per 100 g of fresh leaves as compared with other leafy vegetables (2.0 g in spinach, 4.8 g in mint, and about 1.8 g in cabbage) [47]. Apart from the protein, the plants contain different minerals and vitamins. Notably, 100 g of fresh leaves contain 5.25–7.4 g proteins, 0.58–1.1 g fat, 1.75–1.8 g fiber, 69.9–85.4 g moisture, 5600 μg carotene, 0.21 mg riboflavin, 0.50 mg thiamine, 244–314.3 mg vitamin C, 45.7 mg potassium, 1.62 mg cobalt, 25.6 mg manganese, 768.7 mg copper, 306.3 mg sodium, 15.9 mg zinc, 212.5 mg iron, 664.9 mg magnesium, 84.4–711 mg calcium, 543 mg phosphorus, and 8.8 mg iron [1,46]. Wang and Lee [48] identified nucleosides, flavonoldiosides, and trioside from leaf extracts of *S. androgynus*. Singh et al. [46] identified phytochemicals such as polyphenols, anthocyanins, carotenoids, vitamins, and tannins. Selvi and Baskar [30] noted that leaves of *S. androgynus* contain different compounds such as sterols, terpenoids, glycosides, resins, tannins, saponins, alkaloids, flavonoids, phenols, catechol, cardiac glycosides, and acidic compounds [49]. Yu et al. [50] isolated and identified a novel

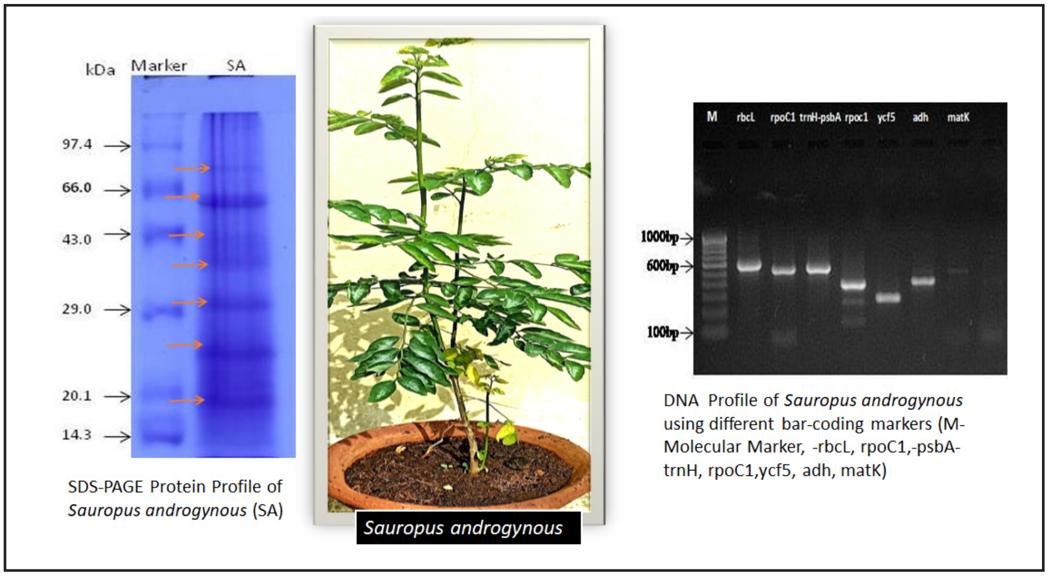

Figure 2: Protein and DNA profile of *S. androgynus* [43].

compound, i.e., 3-*O*-*β*-D-glucosyl-(1-6)-*β*-D-glucosyl-kaempferol, having antiobesity properties. The leaves also recorded high content of flavonoids and organic compounds with antimicrobial, anti-inflammatory, antioxidant, and anticancer properties [6,30]. Sai and Srividya [22] evaluated the aqueous leaf extract of *S. androgynus* on the postprandial glucose levels in human blood. They observed that patients' glycemic index was significantly lower than the control group. *S. androgynus* has a high potential for lowering glucose levels in human blood and helping to reduce diabetes. Over an extended period, more consumption of young leaves resulted in a high weight loss reduction. They have concluded that 3-*O*-*β*-D-glucosyl-(1-6)-*β*-D-glucosyl-kaempferol can be an antiobesity agent. Bhaskar et al. [21] studied wound healing using the water extract of *S. androgynus* with a rat model system. They found that smaller macrophages, fibroblasts, and potential ability as a wound-healing agent repaired wound tissue. Purba and Paengkoum [51] identified the phytochemicals (ascorbic acid, eugenol, gallic acid, caffeic acid, syringic acid, p-coumaric acid, sinapic acid, ferulic acid, catechin, myricetin, quercetin, apigenin, and kaempferol) associated with *S. androgynus* plant and used for various diseases. Kanchanapoom et al. [52] reported the major active compound, "Sauroposide," based on spectral analysis from the aerial part of the plant. Furthermore, Wei et al. [53] identified several organic compounds isolated from the stem extract of *S. androgynus*, which have carboxylic, phenolic, and amino groups. The activity of these phytochemicals is not deepened in the environment. The leaf extract of SA has therapeutic potential [54] and wound-healing properties [55]. Asokawati et al. [56] reported a significant effect on breast milk production and increasing baby weight in the independent practice of maiden district midwives using leaf extract [57].

6. PHARMACOLOGICAL STUDIES

Pharmacological studies are also crucial to studying the toxicity or potential side effects of any extract used by human beings to treat their diseases. Several reports indicate that the herb has multiple bioactive compounds for various therapeutic values. It has been reported that the aqueous leaf extract of *S. androgynus* helps in the reduction of human blood glucose levels [37]. Long-term consumption of young leaves helps lose body weight and is an antiobesity activity. Bhaskar et al. [21] reported that water extract at a low concentration (5%) helps in wound healing activity. Based on a histological study of male and female rats, they observed smaller macrophages, fibroblasts, and rich collegenation. The ethanolic leaf extract showed high anti-inflammatory activity as reported by Selvi and Bhaskar [58]. Soka et al. [10] noted that the leaf extract of *S. androgynus* helps to induce breast milk production. They observed that the oxytocin and prolactin gene expression increased significantly after consuming the leaf extract tested in mice. The leaf extract helps in the early circulation of oxytocin hormone in the bloodstream. Xin et al. [59] studied the cytotoxicity and genotoxicity in CHL-1 human cell lines using different concentrations of fresh and cooked leaf extract of *S. androgynus.* They observed that no changes took place in the chromosomes. It was further reported that the ethanolic extract inhibits cell growth [60]. Subsequently, Yunita et al. [61] evaluated the methanolic leave extract of *S. androgynus* against human mesenchymal stem cells originating from bone marrow. They found that the extract is less cytotoxic to the stem cell with IC50 2450 mg/l. Bunawan et al. [47] reported that the *S. androgynus* herb has potential outbreaks of pulmonary dysfunction. More amount of consumption leads to respiratory failure. Joshi et al. [24] studied the lipophilic fraction of the leaves of *S. androgynus* against viruses using the Vero CCL-81 cell line. They reported that the leaf fraction has potential antiviral activity against dengue, but not chikungunya. Furthermore, the fraction was studied against *P. falciparum* strain 3D7 culture in O+ human erythrocytes and reported no positive effect against malaria parasites. Based on *in silico* analysis, they also noted that β-sitosterol has a strong interaction with the dengue virus E glycoprotein, which inhibits the fusion process.

7. ANTIOXIDANT AND ANTIMICROBIAL ACTIVITY

The nutritional composition of *S. androgynus* varied during different plant growth and development [62]. It has several significant benefits, called multivitamins, and helps with neurological disorders and weight gain [63,64]. The combination of leaf extract of *S. androgynus* and *Moringa oleifera* showed a substantial effect on antioxidant activity [65]. The leaf extract of *S. androgynus* has high flavonoids and vigorous antioxidant activity as reported [21,66]. The study also implies that the plant has free radical scavenging, polyphenol content, cupric ion chelating activities, inhibiting the ferric ion antioxidant properties, and lipid peroxidation [67]. The methanolic and ethanolic extracts have a significant effect on antibacterial activity against *Proteus vulgaris*, *Bacillus cereus*, *Klebsiella pneumonia*, *Staphylococcus* *aureus*, *Bacillus subtilis*, *Escherichia coli*, and *Salmonella typhimurium* [68-70]. Selvi et al. [71] reported that plant extract also has antifungal effects against *Aspergillus flavus* and *Candida albicans*. Fikri et al. [29] observed that leaf extracts prevent infectious diseases, aging, and degenerative diseases due to high vitamin C, polyphenols, and flavonoid compounds. The section shows the high competence of flavonoids, holds back the release of lysosomal content from polyphenolic neutrophils, and donates convincing as an anti-inflammatory activity. Some phytoconstituents such as saponins, tannins, triterpenoids, and coumarin are linked with non-steroidal anti-inflammatory drugs, antinociceptive, and analgesic. Methanolic leaf extract *S. androgynus* is significantly used as multivitamins and peptides, glycosides, alkaloids, saponins, terpenoids, and flavonoids [72]. It is traditionally used to increase the hormone prolactin and oxytocin levels to stimulate lactation. Vitamin A is sourced from carotenoids from *S. androgynus* extract and synthesizes retinol, which reacts with fatty acids to release the hormone prolactin. The hormone prolactin stimulates the development of secretory glands in the intralobular duct. Increased activity of secretary glands with lipids and unilocular fat tissue can prepare mammary glands before letting down milk. Dewajee et al. [73] detected the phytochemicals responsible for the anthelmintic activity, i.e., alkaloids, phytosterols, tannins, flavonoids, saponins, and so on.

8. CONCLUSION

The research analysis highlighted the efficacy of *S. androgynus*, which is an unexploited shrub used for traditional herbal medicine, breast milk inducer, wound healing, and antimicrobial and antioxidant activity. The shrub has more active metabolites such as alkaloids, flavonoids, phenols, terpenoids, glycosides, nutrients, protein, fat, carbohydrates, organic compounds, and vitamins for curing various diseases and treatments. Many researchers have evaluated *S. androgynus* plants' efficacy in making pharmaceutical preparations as patent drugs for therapy. The *S. androgynus* leaves a potential source of phytochemical compounds with health-promoting properties for introspective production. The phytochemical profile variation depends on solvent type, but not on the plant's cultivation location or the sampling time. The authenticity of plant species is also of utmost importance to derived phytochemicals. DNA bar-cording study can identify the authenticating source of the plant. For authenticity, Rout and Swain (unpublished data) [43] used eight barcoding markers to identify the plant species. These barcoding markers are treated as DNA-based molecular markers for future identification. There will be no chance to mix with other herbal drugs. This research analysis provides the biology, phytochemical, and biotechnological overview of *S. androgynus*, which is a multivitamin shrub for human welfare. Further research is necessary to utilize these active compounds to prepare nano-herbal drugs for higher efficiency and usefulness.

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10. AUTHORS' CONTRIBUTIONS

DS and GRR: Literature review and lab experiment. SKM: Research methodology design, statistical analysis, and graphics. BKS and AKP: Plant collection and literature search. GRR: Manuscript writing and editing. All authors approved the manuscript.

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12. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

13. ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

14. DATA AVAILABILITY

All the data is available with the authors and shall be provided upon request.

15. USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

16. PUBLISHER'S NOTE

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