A review of the health benefits of *Strychnos decussata* (Pappe) Gilg (Loganiaceae): a potential functional food

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**ABSTRACT**

*Strychnos decussata* is a small to medium sized tree which naturally occurs in open-wooded and thickets in tropical Africa. A critical appraisal of the medicinal, pharmacological and socio-economic properties of *S. decussata* are provided. Research articles focusing on the medicinal, pharmacological and socio-economic properties of *S. decussata* were searched from online databases such as Google Scholar, PubMed, Science Direct, SciELO and SpringerLink. No time limit was set for the search and all research outputs that aligned with the scope of the review were included. *S. decussata* has diverse uses as a food plant and also has medicinal uses such as charm and ritual, scorpion and snake bite antidote, ethnoveterinary medicine, and traditional medicine for fever, gastro-intestinal problems, headache, respiratory infections, wounds, venereal diseases and infections. *S. decussata* exert biological activities such as antifungal, antmycobacterial, antiplasmodial and convulsant activities. Several phytochemical compounds such as decussine and decussine-type alkaloids, gluco-indole alkaloids and pentacyclic indole alkaloids have been isolated from the species. Many applications of *S. decussata* as source of food and herbal medicines as well as its phytochemistry and pharmarcological properties need further investigations.

**Keywords:** Buddleia family, ethnomedicinal uses, indigenous knowledge, Loganiaceae, *Strychnos decussata*
INTRODUCTION

*Stychnos decussata* (Pappe) Gilg (Figure 1) is a member of the Loganiaceae family often referred to as the Buddleia family. The best known genus in the family is *Buddleia* L., with its members widely grown in gardens all over the world and prized for their bloom and fragrance [1]. The Loganiaceae family includes 16 genera of herbs, climbers, shrubs and trees recorded throughout the neotropics [1-5]. *S. decussata* is also treated as a member of the Strychnaceae family in several publications [6-9]. Recognition of the family Strychnaceae is based on splitting the Loganiaceae family into four families, namely Antoniaceae, Loganiaceae, Spigeliaceae and Strychnaceae [10-11]. The *Strychnos* L. genus includes approximately 200 species ranging from climber shrubs or lianas, subshrubs or shrubs and trees [12], with some species presenting more than one growth habit depending with the surrounding environment [13-14]. The *Strychnos* species are cosmopolitan and have been recorded under tropical and subtropical conditions in America [14-15,18,20-22], tropical Africa [13], Madagascar [13], South and Southeast Asia [16-17], northern and northeastern Australia [19]. The *Strychnos* species have been recorded in dry or wet forests, savannas and grasslands, from sea level to 2000 m above sea level [12]. Several *Strychnos* species are considered to be functional food plants and these include *S. cocculoides* Baker [23-25], *S. gerrardii* N.E.Br. [25], *S. henningsii* Gilg [26-27], *S. innocua* Delile [23-25], *S. madagascariensis* Poir. [23-24,28-29], *S. mitis* S. Moore [30], *S. nux-vomica* L. [31], *S. potatorum* L.f. [32], *S. pungens* Soler. [23-25] and *S. spinosa* Lam. [23-24,33-34].

A review of the pharmacological studies of *Strychnos* species by Ohiri et al. [35] showed that crude extracts and/or alkaloids isolated from 48 species of the genus exhibited muscle-relaxant, convulsant, anticancer, antimicrobial, cytotoxicity and hypotensive properties. Similarly, *S. decussata* is regarded as an important useful
plant species in Mozambique and South Africa, and the species is included in the monograph “medicinal and magical plants of southern Africa: an annotated checklist [36]. This is a botanical encyclopedia of important ethnomedicinal plants in southern Africa providing basic information about uses, description and ethnopharmacological properties of the species. Within this context, this study was undertaken aimed at reviewing the phytochemical, pharmacological and socio-economic properties of *S. decussata*.

**Figure 1. Strychnos decussata.** A: Branch showing flower and leaves (photo: W McCleland) and B: branch showing leaves and fruits (photo: F du Randt)

A systematic review of electronic databases such as Taylor and Francis, Science Direct, Google scholar, Scopus, Web of Science, SpringerLink, SciELO, Pubmed and Elsevier were used. Pre-electronic sources such as national, international journal and other scientific publication, dissertations, theses, books and grey literature with information on the botany, traditional uses, medicinal uses, herbal preparations, phytochemistry and biological activities of *Strychnos decussata* were used. No time limit was set for the search and all literature sources published in English and aligned with the scope of the research were included. The key word *Strychnos decussata* and synonyms of the species such as *Atherstonea decussata*, *Strychnos atherstonei*, *Strychnos baculum* and *Strychnos boinensis* were paired with relevant terms such as “biological activities,” “ethnomedicinal uses,” “food uses,” “phytochemicals,” “Ethnobotany,” “pharmacological properties,” and “Traditional uses”. Information about definition, classification, and regulation of functional foods was obtained from articles published in journals such as Bioactive Compounds in Health and Disease, Functional Food Science, Functional Foods in Health and Disease [37-47].

**Description of Strychnos decussata:** The genus name *Strychnos* is derived from the Greek word for deadly, in reference to the poisonous properties of the alkaloid strychnine which is associated with several *Strychnos* species [48-49]. The species name “*decussata*” is derived from a Latin reference to the leaf arrangement of the species [49]. The synonyms of *S. decussata* include *Atherstonea decussata* Pappe, *Strychnos atherstonei* Harv., *Strychnos baculum* Harv. and *Strychnos boinensis* Jum. & H. Perrier [50-52]. *Strychnos decussata* is often confused with *S. henningsii* which has a similar distributional range. The English common names of *S. decussata* include Cape teak, Chaka’s wood, king’s tree and Panda’s walking stick tree. In the 19th century, *S. decussata* stems were often made into ceremonial sticks
for Zulu chiefs in South Africa, hence the plant’s local name, “king’s tree,” which was derived from this practice [7]. S. decussata is a semi-deciduous, small to medium-sized, multi-stemmed, slender tree with waxy branchlets, often with a dense, somewhat drooping crown growing to about 12 m in height [7,9]. The stems of S. decussata are often dented and knobby, smooth, leaden-grey, and thornless, while branchlets are conspicuous with pale brown lenticels. The leaves of S. decussata are obovate to elliptic in shape, broadest at or above the middle, leathery, glossy green above, hairless with net-veining not visible, apex rounded, and base broadly tapering. The flowers of S. decussata are white to cream in colour, axillary, racemose cymes; they often appear before the leaves, occurring in small, loose, branched heads. The fruits are small, globose in shape, rind thin and soft, with very short hairs, turning orange to red when mature. The leaves and shoots of S. decussata are consumed by game and livestock [9,53]. S. decussata has been recorded in Kenya, Madagascar, Malawi, Mozambique, Somalia, Tanzania, Zambia and Zimbabwe [52,54-55] (Figure 2). The species has been recorded in lowland coastal thickets, bushveld, often along dry watercourses or on termitaria, on hill slopes or rocky watercourses on deep sands at an altitude ranging from 15 m to 1000 m above sea level [7,56].

Figure 2. Distribution of Strychnos decussata in sub-Saharan Africa (https://www.gbif.org/occurrence/map)

Food uses
The fruits of S. decussata are edible [30,57-60] and are used as a snack particularly by children [61-62]. People eat the juicy pulp and fleshy appendages surrounding the seed. The fruits of species such as S. decussata have potential to produce various food products which include porridge, non-alcoholic and alcoholic beverages [63]. Indigenous fruit trees such as S. decussata provide a major part of the food and nutritional requirements of people living in rural areas and some marginalized areas in sub-Saharan Africa. Moreover, fruits of large-fruited Strychnos species such as S. cocculoides, S. madagascariensis, S. pungens and S. spinosa are considered to be delicious and their fruit pulp sometimes dried and stored for later use [64], thereby extending the
shelf-life and availability of the edible fruits. Research by Nhukarume et al. [63] showed that indigenous fruits contribute significantly to the diets of many rural families in sub-Saharan Africa in times of famine and the fruits also provide some essential micronutrients. The fruits of *Strychnos* species are a source of energy and important nutrients such as carbohydrates, sugars, proteins, vitamins, essential minerals and fibres [25,33-34,65], and therefore, may alleviate nutritional insecurity for local communities. There is evidence that daily consumption of fresh fruits reduces the risk of diseases such as cancer and this is linked to organic compounds such as phenols [66] and flavonoids [67] which contribute to the nutritional value and antioxidant and venotonic effects. However, fruits have a high water content and a relatively low food value with calories ranging from 30 to 70 kcal per 100g, and therefore, should be combined with other foods in order to create a balanced diet [68].

The Functional Food Center defines functional food as “natural or processed foods that contain biologically-active compounds, which, in defined, effective, non-toxic amounts, provide a clinically proven and documented health benefit utilizing specific biomarkers, to promote optimal health and reduce the risk of chronic or viral diseases and manage their symptoms” [41,45]. The Functional Food Center has created a classification system categorizing functional foods as A, B or C based on research on their epidemiological and after market studies and the quality of evidence for the functional food product [45]. A classification of A shows that aftermarket research, epidemiological studies and certification of the functional food status has been completed, B indicates completion of epidemiological studies and certification while C indicates that the product has only been certified as functional [45]. Current research focusing on functional foods is emphasizing the importance of international regulatory framework for health-related claims associated with functional foods, particularly the use of these claims in the labelling of functional products [69]. Furthermore, Adany et al. [38] and Martirosyan et al. [45] argue that functional foods should undergo a thorough evaluation process, including publishing such findings in peer reviewed journals to ensure that only safe and effective products will be released to the market. Based on the Functional Food Center’s classification system, *S. decussata* can be accorded a C classification category as there are numerous gaps in aftermarket research, epidemiological studies and certification of the functional food status of the species. Therefore, there is a need for detailed studies aimed at elucidating the micronutrients and phytochemical compounds associated with *S. decussata* that are important for human nutrition and health.

**Medicinal uses of Strychnos decussata:** The bark and roots of *S. decussata* are sold in informal herbal medicine markets as traditional medicines in Mozambique [70] and in the Eastern Cape and Gauteng provinces in South Africa [71-72]. The ground root bark of *S. decussata* is used as snuff in South Africa [7,73,74]. The bark, leaf, roots, root bark, root powder and stem bark infusions and/or decoctions of *S. decussata* are mainly used as charm and ritual, scorpion and snake bite antidote, and ethnoveterinary medicine, and traditional medicine for fever, gastro-intestinal problems, headache, respiratory infections, wounds, venereal diseases and infections in Kenya, Madagascar, Mozambique and South Africa (Table 1; Figure 3). Other medicinal applications of *S. decussata* which are supported by at least two literature records include the use of roots as anthelmintic in Mozambique [70,75] and the use of stem bark against ulcers in Kenya [57,76]. Research by Famewo et al. [77,78] revealed that *S. decussata* is an ingredient of a polyherbal medicine mixed with *Agathosma betulina* (P.J. Bergius) Pillans, *Allium sativum* L. (bulb), *Daucus carota* L. (roots),
Glycyrrhiza glabra L. (roots), Gunnera perpensa L. (rhizome), Hypoxis argentea Harv. ex Baker (corms) and Menta x piperita L. (leaves) used as traditional medicine against tuberculosis. The bark of *S. decussata* is also mixed with the corms of *H. argentea*, Centella eriantha (A. Rich.) Drude (rhizome), Kniphofia dreyanophylla Baker (roots), Myrsine melanoploeos (L.) R.Br. ex Sweet (bark) and Pentanisia prunelloides (Klotzsch) Walp (rhizome) as traditional medicine for tuberculosis [77-79]. Similarly, the bark of *S. decussata* is also mixed with the roots of Hermannia spp. and Lauridia tetragona (L.f.) R.H. Archer as traditional medicine for tuberculosis [77,78]. Research by Famewo et al. [77] showed that the polyherb remedies including the bark of *S. decussata* contain anti-tubercular activities against *Mycobacterium tuberculosis*, a bacterium which causes tuberculosis.

Table 1: Medicinal uses of *Strychnos decussata*.

<table>
<thead>
<tr>
<th>Medicinal uses</th>
<th>Parts used</th>
<th>Country</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscesses</td>
<td>Root infusion applied topically</td>
<td>Madagascar</td>
<td>80</td>
</tr>
<tr>
<td>Anthelmintic</td>
<td>Root decoction taken orally</td>
<td>Mozambique</td>
<td>70,75</td>
</tr>
<tr>
<td>Blood purification, cleansing or detoxification</td>
<td>Bark infusion taken orally</td>
<td>South Africa</td>
<td>81</td>
</tr>
<tr>
<td>Charm and ritual (lightning and protection)</td>
<td>Bark and roots used</td>
<td>South Africa</td>
<td>1,7,9,36,73,81-91</td>
</tr>
<tr>
<td>Fever</td>
<td>Bark decoction taken orally</td>
<td>South Africa</td>
<td>92-95</td>
</tr>
<tr>
<td>Gastro-intestinal problems</td>
<td>Leaf, root, root bark and stem bark decoction or infusion taken orally</td>
<td>Kenya, Madagascar and South Africa</td>
<td>1,7,25,30,36,48,57,7,3,76,80,84,85,96-98</td>
</tr>
<tr>
<td>Headache</td>
<td>Bark infusion taken orally</td>
<td>South Africa</td>
<td>92-94,99</td>
</tr>
<tr>
<td>Anti-inflammation</td>
<td>Root infusion applied topically</td>
<td>Madagascar</td>
<td>80</td>
</tr>
<tr>
<td>Antimalarial</td>
<td>Leaf infusion taken orally</td>
<td>Madagascar</td>
<td>80</td>
</tr>
<tr>
<td>Rheumatic pain</td>
<td>Leaf decoction applied topically</td>
<td>Madagascar</td>
<td>100</td>
</tr>
<tr>
<td>Scorpion and snake bite antidote</td>
<td>Root decoction or infusion taken orally or root powder applied externally</td>
<td>South Africa</td>
<td>30,41,81-82,84,101-106</td>
</tr>
<tr>
<td>Respiratory infections (sore throat and tuberculosis)</td>
<td>Bark decoction taken orally</td>
<td>South Africa</td>
<td>77-78,92-95,107</td>
</tr>
<tr>
<td>Anti-tuberculosis</td>
<td>Bark mixed with leaves of Agathosma betulina (P.J. Bergius) Pillans, Allium sativum L. (bulb), Daucus carota L. (roots), Glycyrrhiza glabra L. (roots), Gunnera perpensa L. (rhizome), Hypoxis argentea Harv. ex Baker (corms) and Menta x piperita L. (leaves)</td>
<td>South Africa</td>
<td>77-78</td>
</tr>
<tr>
<td>Anti-tuberculosis</td>
<td>Bark mixed with the corms of <em>H. argentea</em>, Centella eriantha (A. Rich.) Drude (rhizome), Kniphofia dreyanophylla Baker (roots), Myrsine melanoploeos (L.) R.Br. ex Sweet (Bark) and Pentanisia prunelloides (Klotzsch) Walp (rhizome)</td>
<td>South Africa</td>
<td>77-79</td>
</tr>
<tr>
<td>Anti-tuberculosis</td>
<td>Bark mixed with roots of Hermannia spp. and Lauridia tetragona (L.f.) R.H. Archer</td>
<td>South Africa</td>
<td>77-78</td>
</tr>
<tr>
<td>Anti-ulcer</td>
<td>Stem bark decoction taken orally</td>
<td>Kenya</td>
<td>57,76</td>
</tr>
<tr>
<td>Venereal diseases and infections</td>
<td>Bark decoction taken orally</td>
<td>Madagascar and South Africa</td>
<td>92-94,100,108</td>
</tr>
<tr>
<td>Wounds</td>
<td>Bark and roots infusion applied topically</td>
<td>Madagascar and South Africa</td>
<td>80,92-94</td>
</tr>
<tr>
<td>Ethnoveterinary medicine (helminthiases and roundworms in cows)</td>
<td>Bark and roots</td>
<td>Mozambique and South Africa</td>
<td>70,109-114</td>
</tr>
</tbody>
</table>
Figure 3. Medicinal uses of Strychnos decussata in sub-Saharan Africa.

Phytochemical composition of Strychnos decussata: Several phytochemical compounds such as decussine and decussine-type alkaloids, gluco-indole alkaloids and pentacyclic indole alkaloids have been isolated from the leaves and stem bark of S. decussata [115-119]. Some of the medicinal properties exhibited by S. decussata could be linked to the different alkaloids identified from the species as alkaloids are known to exhibit antibacterial, anticholinesterase, antifungal, antioxidant, antiviral, antimalarial, hepatoprotective, hypoglycemic, antispasmodic, oxytocic, antipyretic, anxiolytic, anticancer, anti-inflammatory, analgesic, cytotoxicity and antidepressant properties [120-122]. Moreover, alkaloids are known to be useful as diet ingredients, supplements and stimulants [121].

Table 2. Phytochemical composition of Strychnos decussata.

<table>
<thead>
<tr>
<th>Phytochemical compound</th>
<th>Chemical formula</th>
<th>Plant part</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluco-alkaloid</td>
<td>-</td>
<td>Leaves</td>
<td>115</td>
</tr>
<tr>
<td>Akagerine</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>117</td>
</tr>
<tr>
<td>17-O-Methyl-akagerine</td>
<td>C_{20}H_{23}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>117</td>
</tr>
<tr>
<td>10-Hydroxy-17-O-methyl-akagerine</td>
<td>C_{20}H_{21}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>117</td>
</tr>
<tr>
<td>10-Hydroxy-21-O-methyl-kribine</td>
<td>C_{20}H_{23}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>117</td>
</tr>
<tr>
<td>10-Hydroxy-epi 21-O-methyl-kribine</td>
<td>C_{20}H_{21}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>117</td>
</tr>
<tr>
<td>10-Hydroxy-akagerine</td>
<td>C_{20}H_{21}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>116</td>
</tr>
<tr>
<td>Akagerine lactone</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>116</td>
</tr>
<tr>
<td>Decussine</td>
<td>C_{20}H_{23}N_{3}</td>
<td>Stem bark</td>
<td>119</td>
</tr>
<tr>
<td>3,14-Dihydro-decussine</td>
<td>C_{20}H_{22}N_{3}</td>
<td>Stem bark</td>
<td>119</td>
</tr>
<tr>
<td>10-Hydroxy-3,14-dihydro-decussine</td>
<td>C_{20}H_{22}N_{3}</td>
<td>Stem bark</td>
<td>119</td>
</tr>
<tr>
<td>Rouhamine</td>
<td>C_{20}H_{21}N_{3}</td>
<td>Stem bark</td>
<td>119</td>
</tr>
<tr>
<td>Bisnordihydrotoxiferine</td>
<td>C_{20}H_{21}N_{4}</td>
<td>Stem bark</td>
<td>119</td>
</tr>
<tr>
<td>Macusine A</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>118</td>
</tr>
<tr>
<td>Macusine B</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>118</td>
</tr>
<tr>
<td>Macusine C</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>118</td>
</tr>
<tr>
<td>Malindine</td>
<td>C_{20}H_{22}N_{3}</td>
<td>Stem bark</td>
<td>118</td>
</tr>
<tr>
<td>O-Methyl-macusine</td>
<td>C_{20}H_{22}N_{2}O_{2}</td>
<td>Stem bark</td>
<td>118</td>
</tr>
</tbody>
</table>
Pharmacological properties of *Strychnos decussata*: The following biological activities have been reported from the stem bark of *S. decussata* and alkaloids isolated from the species: antifungal [92,94], antimycobacterial [77], antiplasmodial [80] and convulsant [117-118] activities.

**Antifungal activities:** Samie et al. [92] evaluated the antifungal activities of acetone and hexane extracts of *S. decussata* stem bark against *Candida albicans*, *Cryptococcus neoformans* and *Candida krusei* using the agar diffusion and the microdilution methods with nystatin and fluocytosine as positive controls. The extracts exhibited activities against the tested pathogens with the minimum inhibitory concentration (MIC) values ranging from 1.9 mg/ml to >7.5 mg/ml [92]. Samie and Mashau [94] evaluated the antifungal activities of hexane extracts of *S. decussata* stem bark against *Fusarium verticillioides*, *Fusarium oxysporum*, *Fusarium nygamai*, *Fusarium graminearum* and *Fusarium proliferatum* using the hole plate diffusion and the microdilution methods with nystatin as positive control. The extract exhibited activities against the tested pathogens with MIC values ranging from 3.8 mg/ml to >7.5 mg/ml [94]. The antifungal activities exhibited by *S. decussata* stem bark extracts corroborate the medicinal uses of the species against opportunistic diseases and infections such as abscesses [80], gastro-intestinal problems [1,7,25,30,36,48,57,73,76,80,84,85,96-98], inflammation [77-78, 92-95,107], venereal diseases and wounds [80, 92-94,100,108].

**Antimycobacterial activities:** Traditional medicines are widely used against tuberculosis [123-129], a life-threatening disease in animals and humans caused by various *Mycobacterium* species. *S. decussata* is one of the medicinal plants used to treat and manage tuberculosis-related symptoms [77] and in vitro activity testing against target pathogenic microorganisms such as *Mycobacterium tuberculosis* is important. Research by Kabongo-Kayoka et al. [130] showed that substances or natural products that can either inhibit the growth of *M. tuberculosis* or kill it while having little or no toxicity to host cells are considered good candidates for developing new anti-tubercular drugs. Famewo et al. [77] evaluated the antimycobacterial activities of ethanol herbal mixture of *S. decussata* with *Agathosma betulina*, *Allium sativum*, *Centella eriantha*, *Daucus carota*, *Glycyrrhiza glabra*, *Gunnera perpensa*, *Hermannia spp.*, *Hypoxis argentea*, *Kniphofia drepanophylla*, *Lauridia tetragonia*, *Menta piperita*, *Pentanisia prunelloides* and *Rapanea melanophloeos* against *Mycobacterium tuberculosis* with isoniazid (0.05 µg/ml) as a positive control. The mixture showed activities with MIC values ranging from <1.6 µg/ml to 25.0 µg/ml while the positive control exhibited MIC value of 0.05 µg/ml [77].

**Antiplasmodial activities:** Malaria is caused by single-celled parasites of the genus *Plasmodium*, particularly *P. falciparum*, *P. knowlesi*, *P. malariae*, *P. ovale* and *P. vivax* [131]. Therefore, traditional medicines, other therapeutic and preventative drugs against malaria usually interfere with different phases of the *Plasmodium* species life cycle [132-133]. Rasoanaivo et al. [80] evaluated the antiplasmodial activities of the crude alkaloid extracts isolated from *S. decussata* against a chloroquine-resistant *Plasmodium falciparum* strain using the [3H]-hypoxanthine incorporation assay with chloroquine as a positive control. The crude alkaloid extracts exhibited antiplasmodial activities in the *in vitro* experimental model with half maximal inhibitory concentration (IC50) value of 19.7 µg/ml in comparison with IC50 values ranging from 0.01 µg/ml to 0.1 µg/ml exhibited by the positive control [80]. The antiplasmodial activities exhibited by the crude alkaloid extracts of *S. decussata* corroborate the medicinal applications of the species against malaria in Madagascar. Moreover, six
Strychnos species are used as traditional medicines against malaria in Madagascar and such species include *S. decussata*, *S. diplatricha* Leeuwenb., *S. henningsii*, *S. madagascariensis*, *S. mostueoides* Leeuwenb. and *S. myrtoides* Gilg & Busse [80].

**Convulsant activities:** Rolfsen et al. [117] evaluated the convulsant activities of the alkaloids, akagerine, 17-O-methyl-akagerine, 10-hydroxy-17-O-methyl-akagerine, 10-hydroxy-21-O-methyl-kribine and 10-hydroxy-epi 21-O-methyl-kribine isolated from the stem bark of *S. decussata* using strychnine as the standard drug. The alkaloids exhibited potent convulsant activities with half maximal curative dose (CD$_{50}$) ranging from 45.3 mg/kg to 84.0 and half maximal lethal dose (LD$_{50}$) ranging from 47.5 mg/kg to 90.0 mg/kg. The alkaloids exhibited typical extension component of the tonic convulsions, although they were less active than strychnine [117]. Similarly, Olanii et al. [118] evaluated the convulsant activities of the alkaloid malindine obtained from the water-soluble fraction of the stem bark of *S. decussata*. The alkaloid malindine exhibited muscle-relaxant activities when injected intraperitoneally in mice and also produced a 50.0% reduction in the amplitude of the concentration of a diaphragm-muscle preparation at a dose of 0.5 mg/ml [118].

Recent research by Setubal et al. [12] attributed convulsant activities exhibited by *Strychnos* species to alkaloids, particularly strychnine which is known to exhibit the convulsant effects when ingested [12]. The indole alkaloid strychnine is a central nervous system stimulant, inhibits a glycine receptor, increases excitability of all parts of the central nervous system causing symmetric muscular spasms, convulsions, salivation, irreversible contraction of the bronchial muscles and sometimes death from respiratory arrest or cardiac arrest [134-135]. Similarly, Tits et al. [136] evaluated the antispasmodic activities of the alkaloids such as brucine, holstine, isoretuline, O-acetylisoretuline and retuline isolated from a closely related species *S. henningsii* using the myostimulating effect of histamine and bradykinin on guinea-pig ileum. The alkaloid isoretuline exhibited moderate activities [136].

**CONCLUSION**

This review established the food value and medicinal uses of *S. decussata*. *S. decussata* contains several alkaloid compounds that are pharmacologically and pharmaceutically valuable. The species also demonstrated some pharmacological activities which need further investigation, such as antifungal, antimycobacterial, antiplasmodial and convulsant activities. Further research should focus on detailed pharmacological research, in vivo and clinical studies, as well as toxicological evaluations. The results obtained are promising and this species should be explored further to decipher its true ethnomedicinal and pharmacological worth.

**List of abbreviations:** CD$_{50}$: half maximal curative dose, IC$_{50}$: half maximal inhibitory concentration, LD$_{50}$: half maximal lethal dose, MIC: minimum inhibitory concentration

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