# Review Article: Recent Advances in Isolation and Antimicrobial Efficacy of Selected *Strychnos* Species: A Mini Review

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## ABSTRACT

Treatments of various diseases in pharmacology through herbs have begun a long time ago. Herbal medicines have been in practice since time immemorial, and over 80% of the global population depends on medicinal plants to treat disease. Medicinal plants contain active ingredients for functional therapeutics purposes, such as antimicrobial agents. Examples of those medicinal plants are found in different plant species belonging to different families such as *Boraginaceae*, *Loranthaceae*, *Urticaceae*, *Plantaginaceae*, *Loganiaceae*, *Lamiaceae,* among others. The genus, *Strychnos* belongs to the family of *Loganiaceae* and consists of about 200 species. Isolated compounds and antimicrobial of a few species from the *Strychnos* genus have been reported recently. This review aimed to detail the isolated compounds and antimicrobial efficacy of selected *Strychnos* species reported within 2014 – 2021. Based on the MIC result, the antimicrobial efficacy indicated that extracts of *S. madagacariensis* and *S. pungens* have the highest activity against *S. typhi*, extract of *S. lucida* have highest activity against *B. cereus* and *S. pyogenes*, extract of *S. spinosa* showed better activity against *K. pneumonia* and *B. subtilis*, extract of *S. nux-vomica* has highest activity against *S. aureus*, *P. aeruginosa* and *E. faecalis* while extract *of S. colubrine* exhibited excellent activity against *C. perfringens*. About thirty compounds belonging to alkaloids, terpenoid, terpene, steroids and other class and their pharmacological properties were reviewed in this study. This is concluded that the *Strychnos* species under this review contains a wide variety of compounds belonging to different classes of phytochemical, possessing significant antimicrobial activity.

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## 1. Introduction

The prevalence of the infectious disease has been documented throughout history, and hence the establishment of a healthcare scheme is critical for the quality of life that everyone desire [1, 2].

Herbal remedies are discovered and made known through the traditional therapeutic system while herbal treatments for many diseases have been used in pharmacology for a long time ago. These techniques are known as folk healing and have been used worldwide [3, 4].

Alternative medicine and traditional medicine is known as herbal medicine, has been used in India since time immemorial, according to reference [5]. Plant-based medications are used by about 80% of the world's population for therapeutic purposes, according to reports by reference [5]. These are incredibly beneficial in primary healthcare, extending from rural areas in developing countries to developed ones where modern medicines are primarily employed.

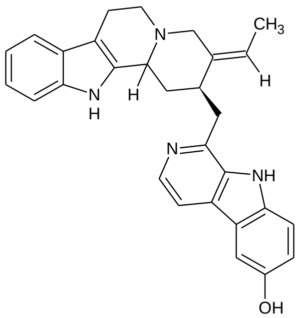
Due to the presence of active chemicals in medicinal plants, they are regarded as complementary therapeutics and have improved the management of ill-health problems [6]. Many of these active ingredients in plants are known as phytochemicals, and they have been shown to have therapeutic properties such as antidepressant activity [7], antioxidant activity [8], antimicrobial activity [9] and other biological activities.

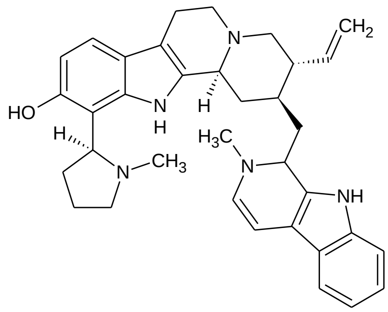
Antimicrobials derived from plants have a lot of medicinal potentialities as reported by reference [10]. Mohammadi and co-workers [11] studied the antibacterial activity of silver nanoparticles (AgNps) generated from a mixture of *Ferula gumosa*, *Ferula latisecta*, *Teucrium polium*, and *Trachomitum venetum* leaves and stem bark extracts. A review of Zirconia Nanoparticles produced from plant extracts for medical uses has been published [12]. Selenium nanoparticles made from plant extracts have been studied for various biological applications [13]. Several researches on the antimicrobial activity of medicinal plant extracts have found that they are effective against microbial infections. Compounds isolated from plants, including the genus *Heracleum*, have been reported [14].

Bacterial and fungal diseases significantly influence on public health, and their resistance to antibiotics has prompted increased medical worry [15]. Humans contract bacterial infections from the air, food, water, or living vectors [16]. Despite this, many bacteria organisms in human bodies do not cause disease. Bacterial cellulitis, strep throat, vaginosis, bacterial, syphilis, gonorrhoea, chlamydia, tuberculosis, tetanus, cholera, botulism, and various other infections can all be caused by bacteria that enter human bodies. Ringworm, vaginal yeast infection, thrush, histoplasmosis, aspergillosis, fungus meningitis, are examples of fungi infections [17].

*Strychnos* is one of the largest genera in the *Loganiaceae* family, Linnaeus initially discovered based on *Strychnos nux-uomica*, a type species, and *Strychnos colubrine* (*Strychnos minor*). It is pantropical and has approximately 200 species, classified into three geographical groups: 75 species in Africa, 73 species in America, and 44 species in Asia (including Australia). *Strychnos potatorum*, which may be found in Asia and Africa, is an exception [18]. As a result, the purpose of this review was to describe the chemical compounds and antimicrobial efficacy of some selected *Strychnos* species (*Strychnos colubrine*, *Strychnos potatorum*, *Strychnos nux-vomica*, *Strychnos lucida*, *Strychnos Spinosa*, *Strychnos madagacariensis*, *Strychnos nigritana*, *Strychnos johnsonii*, *Strychnos pungens*) reported in recent time.

## 2. Results and Discussion


10′-Hydroxyusambarensine (**1**)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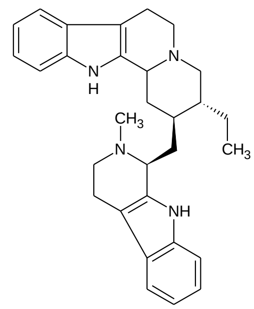
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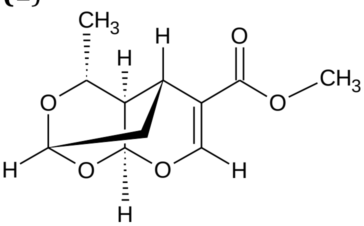
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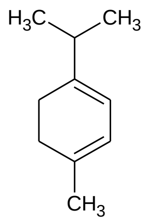
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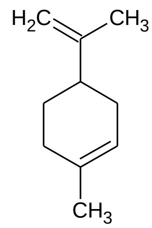
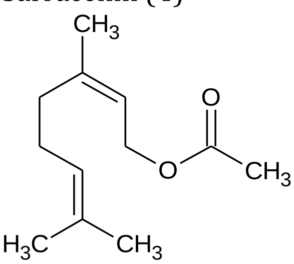

Limonene (**6**)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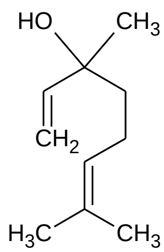
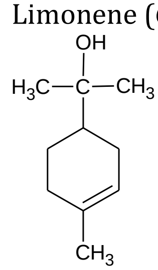
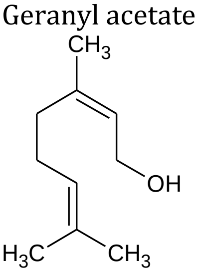
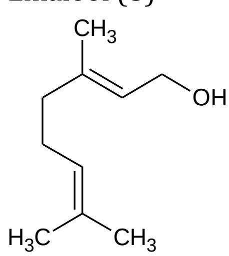

Linalool (**8**)


α-Terpineol (**9**)


Nerol (**10**)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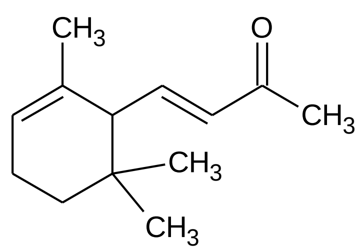
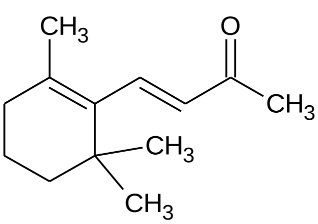
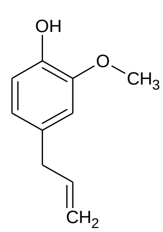

α-Ionone (**12**)


β-Ionone (**13**)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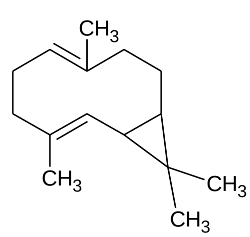
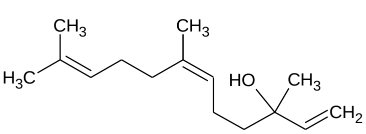
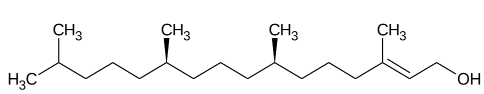
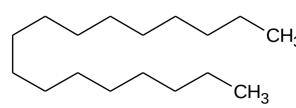
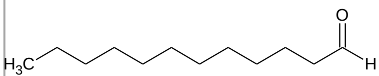

Bicyclogermacrene (**16**)

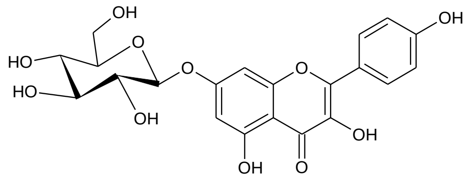

Nerolidol (**14**)


Phytol (**15**)

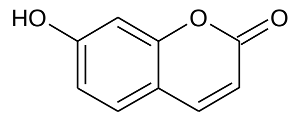

Heptadecane (**18**)



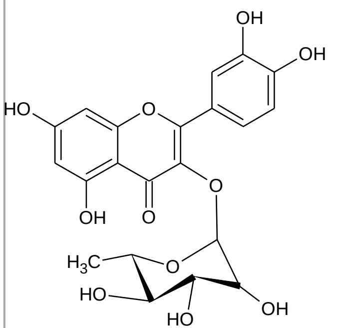
Dodecanal (**19**)



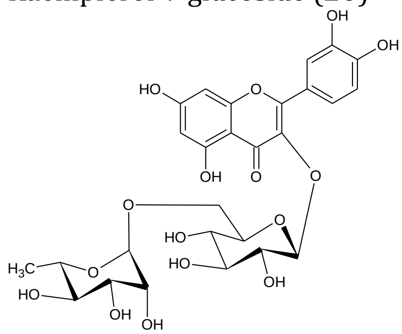
Kaempferol-7 glucoside (**20**)



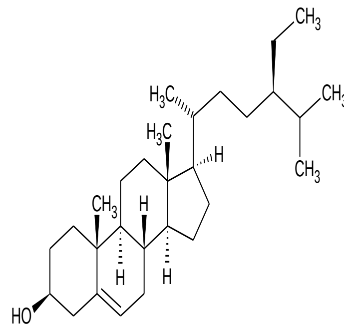
7-Hydroxy coumarin (**21**)



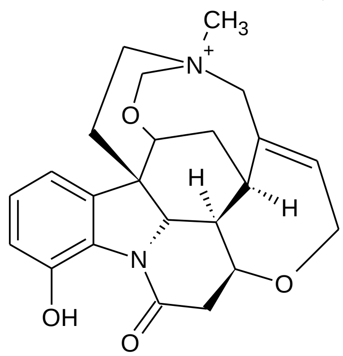
Quercetin-3-rhamnoside (**22**)



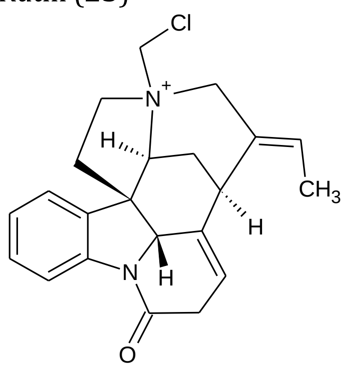
Rutin (**23**)



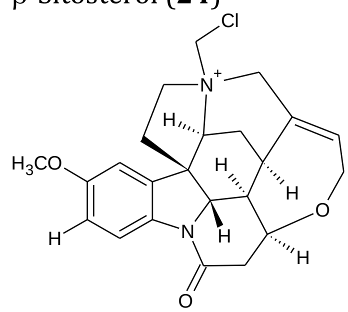
β-Sitosterol (**24**)



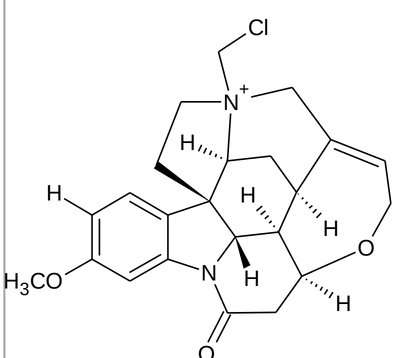
Stryvomicine A (**25**)



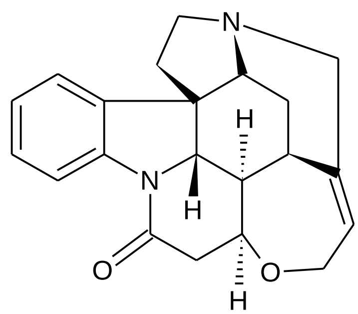
Deoxy-isostrychnine-chloromethochloride (**26**)



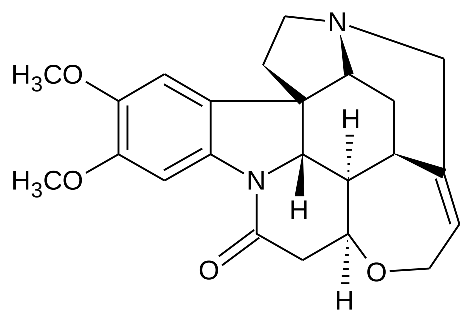
β-Colubrinechloromethochloride (**27**)



α-Colubrine-chloromethochloride (**28**)



Strychnine (**29**)



Brucine (**30**)

**Figure 1.** Structure of various chemical compounds isolated from *Strychnos* species

### *2.1 Antimicrobial activity*

Scientists have synthesized certain antibacterial drugs that are available on the market. Medicinal plants are said to have a variety of phytocompounds that defend them from pathogens and are thought to be a source for a variety of antimicrobial chemicals [19].

The antimicrobial activity of nine *Strychnos* species (*S. colubrine*, *S. nigritana*, *S. potatorum*, *S. pungens*, *S. nux-vomica*, *S. johnsonii*, *S. lucida*, *S. Spinosa*, and *S. madagacariensis*) were investigated. The antimicrobial activity of these plants' extracts were tested against nineteen microbial pathogens, seven of which were gram-positive: *Staphylococcus aureus*, *Clostridium* *perfringens*, *Enterococcus faecalis*, *Methicillin-resistant Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Streptococcus pyogenes,* eight of which were gram-negative: *Escherichia coli*, *Providencia stuartii*, *Pseudomonas aeruginosa*, *Prevotella intermedia*, *Salmonella typhi*, *Shigella dysenteriae*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and four fungi: *Aspergillus niger*, *Aspergillus niger*, *Aspergillus niger*, *Aspergillus niger* (**Table 1**).

The methanol fruit pulp extracts of *S. spinosa*, *S. madagacariensis*, *S. pungens* and methanol root bark extract of *S. colubrine* showed antimicrobial activity against *S. typhi* with *S. madagacariensis*, *S. pungens* been highest with minimum inhibitory concentration of 12.5 mg/mL. The petroleum seed extract of *S. nux-vomica* and aqueous root bark extract of *S. colubrine* have no antimicrobial activity against *S. typhi* while the ethyl acetate extract of *S. colubrine* exhibits the highest zone of inhibition 13.2 mm at 80 mg/mL [20–22].

The antimicrobial activity of n-hexane stem bark and twig extracts of *S. lucida* against *S. pyogenes* and *B. cereus* was compared to that of methanol fruit pulp extract of *S. spinosa*, *S. madagacariensis* and *S. pungens*. According to the findings, *S. lucida* has the highest minimum inhibitory concentration of 0.064 and 0.032 mg/mL for *B. cereus* and *S. pyogenes* respectively [22, 23]. The methanol fruit pulp extracts of *S. spinosa*, *S. madagacariensis* and *S. pungens* showed antimicrobial activity against *K. pneumonia and P. intermedia* with *S. spinosa* having a higher MIC value (12.5 mg/mL) for *K. pneumonia* and similar MIC values (25.0 mg/mL) for *P. intermedia* for all three plants [22].

Based on the MIC values of hexane stem bark and twig extracts of S. *lucida*, petroleum seed extract of *S. nux-vomica*, ethyl acetate twig extracts of *S. lucida* and methanol root bark extract of *S. colubrine*. the MIC values of indicated that *B. subtilis* is most susceptibility to the n-hexane stem bark and twig extracts of *S. lucida* , which have a MIC of 0.032 mg/mL while the petroleum seed extract of *S. nux-vomica* has no antimicrobial action against *B. subtilis* [20, 21, 23]

The significant difference was observed on MIC value between ethanol stem bark extract of *S. johnsonii*, aerial plant part extract of *S. nigritana*, leaves extract of *S. nux-vomica*, Petroleum ether extract of seed of *S. nux-vomica*, methanol, ethyl acetate, aqueous root bark extract of *S. colubrine* and aqueous, ethanol seed extract of *S. potatorum* against *S. aureus*. The results revealed that the leaves extract of *S. nux-vomica* has the highest MIC of 0.2 mg/mL [21, 24–27]. The methanol root bark extract *of S. colubrine* exhibited excellent activity against *C. perfringens*, Ethyl acetate and aqueous extract do not show activity against *C. perfringens* [21]. *S. aureus* has been identified as the most common bacteria responsible for various human diseases [28].

The MIC values of leaves extract of *S. nux-vomica* against *P. aeruginosa* and *E. faecalis* were compared to those of ethanol seed extract of *S. potatorum*. The leaves extract of *S. nux-vomica* demonstrated a better MIC result (0.1 mg/mL) for both *P. aeruginosa* and *E. faecalis* [24, 26].

The study on antifungal activity of ethanol seed extract of *S. nux-vomica* was found to be ineffective against the fungal strains: *A. niger*, *A. flavus* and *C. albicans* [20]. Based on the MIC values of leaves extract of *S. nux-vomica*, petroleum seed extract of *S. nux-vomica* and ethanol seed extract of *S. potatorum*. It is indicated that *E. coli* has the highest susceptibility to the leaves extract of *S. nux-vomica* with a MIC of 0.1 mg/mL [20, 24, 26]. The leaves extract of *S. nux-vomica* has similar MIC value for both *Methicillin-resistant Staphylococcus aureus* and *A. baumannii* [24].

### *2.2 Isolated compounds*

**Table 2** and **Figure 1** show the list and structure of isolated compounds reported in the *Strychnos* species under investigation. About thirty compounds belonging to alkaloids (10′-Hydroxyusambarensine, Strychnopentamine, Nigritanine, Stryvomicine A, deoxy-isostrychnine-chloromethochloride, β-colubrinechloromethochloride, α-colubrine-chloromethochloride, Strychnine and brucine), Terpenoid (Sarracenin, Linalool, α-Terpineol, Nerol, Geraniol, α-Ionone, β-Ionone, Nerolidol and Phytol), Terpene (α-Terpinene, Limonene, Geranyl acetate and Bicyclogermacrene), Flavonoid (Kaempferol-7 glucoside, 7-Hydroxy coumarin, Quercetin-3-rhamnoside, Kaempferol 3-rutinoside and Rutin), Steroids (β-sitosterol) and others (Eugenol, Heptadecane and Dodecanal) were reviewed in this study.

Isolation of 10′-Hydroxyusambarensine and Strychnopentamine from *S. usambarensis* was reported by [29], these compounds belong to the alkaloid group. 10'-Hydroxyusambarensine is potent against two strains of *Plasmodium falciparum* [30] while Strychnopentamine is reported to have anticancer properties [31].

Sarracenin was isolated from S. *spinosa* by [32]. It was also found to have cytotoxic properties after being isolated from *Patrinia heterophylla* [33]. Nigritanine is a compound isolated from *S. nigritana* that has been shown to exhibit antimicrobial activity against *S. aureus* [27].

*S. axillaris* contains α-Terpinene, which has been shown to have antihypertensive, antiulcer, antioxidant, anticancer effects [34, 35]. Limonene is also found in *S. axillaris* [35] and Kaempferol-7 glucoside isolated from *S. nux-vomica* [36] has been shown to have Anti-Inflammatory Activity [37- 39].

Brucine isolated from *S. nux-vomica* has been shown to have antitumor, anti-Inflammatory and analgesic effects [40-42]. *S. nux-vomica* contains 7-Hydroxy coumarin and has been shown to have antidiarrheal and antiulcerogenic properties [36-41].

**Table 1.** Report of antimicrobial efficacy of *Strychnos* species

| Botanical Name | Plant Parts Used (Solvent) | Tested microbial organisms | Ref. |
|---|---|---|---|
| *Strychnos potatorum* | Seed (aqueous and ethanol) | *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Enterococcus faecalis* | [26] |
| *Strychnos colubrine* | Root bark (methanol, ethyl acetate, aqueous) | *Clostridium perfringens*, *Salmonella typhi*, *Bacillus subtilis* and *Staphylococcus aureus* | [21] |
| *Strychnos nux-vomica* | Seed (petroleum ether) | *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumonia*. *Salmonella typhi*, *Bacillus Subtilis*, *Aspergillus niger*, *Aspergillus flavus* and *Candida albicans* | [20] |
| *Strychnos nux-vomica* | Leaves | MRSA, *Escherichia coli*, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Staphylococcus aureus*, and *Enterococcus faecalis* | [24] |
| *Strychnos spinosa* | Fruits pulp (methanol) | *Salmonella typhi*, *Streptococcus pyogenes*, *Bacillus cereus*, *Klebsiella pneumonia* and *Prevotella intermedia* | [22] |
| *Strychnos lucida* | Stem bark, twig (hexane, ethyl acetate) | *Bacillus Subtilis*, *Bacillus cereus* and *Streptococcus pyogenes* | [23] |
| *Strychnos nigritana* | | *Staphylococcus aureus* | [27] |
| *Strychnos madagacariensis* | Fruit pulp (methanol) | *Salmonella typhi*, *Streptococcus pyogenes*, *Bacillus cereus*, *Klebsiella pneumonia*, and *Prevotella intermedia* | [22] |
| *Strychnos johnsonii* | Stem bark (ethanol) | *Staphylococcus aureus* | [25] |
| *Strychnos pungens* | Fruit pulp (methanol) | *Salmonella typhi*, *Streptococcus pyogenes*, *Bacillus cereus*, *Klebsiella pneumonia* and *Prevotella intermedia* | [22] |

**Table 2.** Report of phyto-compounds isolated from *Strychnos* species

| Botanical Name: | Plant parts used (Solvent) | Phyto-compounds | Ref. |
|---|---|---|---|
| *Strychnos usambarensis* | | 10′-Hydroxyusambarensine (**1**) and Strychnopentamine (**2**) | [29] |
| *Strychnos nigritana* | | Nigritanine (**3**) | [27] |
| *Strychnos spinosa* | Root bark (ethanol) | Sarracenin (**4**) | [32] |
| *Strychnos axillaris* | Leave (aqueous) | α-Terpinene (**5**), Limonene (**6**), Geranyl acetate (**7**), Linalool (**8**), α-Terpineol (**9**), Nerol (**10**), Geraniol (**11**), α-Ionone (**12**), β-Ionone (**13**), Nerolidol (**14**), Phytol (**15**), Bicyclogermacrene (**16**), Eugenol (**17**), Heptadecane (**18**), Dodecanal (**19**) | [35] |
| *Strychnos nux-vomica* | Leaves (aqueous, methanol) | Kaempferol-7 glucoside (**20**), 7-Hydroxy coumarin (**21**), Quercetin-3-rhamnoside (**22**) and Rutin (**23**) | [36] |
| *Strychnos lucida* | Stem bark (n-hexane) | β-sitosterol (**24**) | [23] |
| *Strychnos nux-vomica* | Seeds | Stryvomicine A (**25**), deoxy-isostrychnine-chloromethochloride (**26**), β-colubrinechloromethochloride (**27**) and α-colubrine-chloromethochloride (**28**) | [39] |
| *Strychnos nux-vomica* | Seed | Strychnine (**29**) and brucine (**30**) | [40] |

## 3. Conclusions

In this study, thirty compounds were reviewed to be isolated from extracts of various plant sections of chosen *Strychnos* species. The antimicrobial properties of extracts from these *Strychnos* species were also reviewed, and they were found to be effective against the infections tested. It can be concluded that *Strychnos* species have wide variety of compounds based on information available from literature. These compounds essential belong to various classes of phytochemical, including alkaloids, terpenoid, terpene, steroids and other important classes. Hence, these compounds are reported to possess significant pharmacological properties.

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## Conflict of Interest

The author declares that there is no conflict of interest.

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