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Ethnobotany, chemistry and toxicity of *Petivera alliacea*: A review

Ibrahim Oduola Lawal[1*], Linda Ifeanyichukwu Sowunmi[1], Musbau Bayonle Olaniyi[1], Adelola Esther Jegede[1], Funmilola Olamide Akanni[1], Idayat Adeola Akinwumi[2], and Oyinkansade Yetunde Babalola[1]

[1]Biomedicinal Research Centre, Forestry Research Institute of Nigeria, PMB 5054, Jericho Hills, Ibadan, Nigeria;

[2]Department of Pharmacognosy, Faculty of Pharmacy, Lead City University, Ibadan, Nigeria

***Corresponding author**: Ibrahim Oduola Lawal, Biomedicinal Research Centre, Forestry Research Institute of Nigeria, PMB 5054, Jericho Hills, Ibadan, Nigeria

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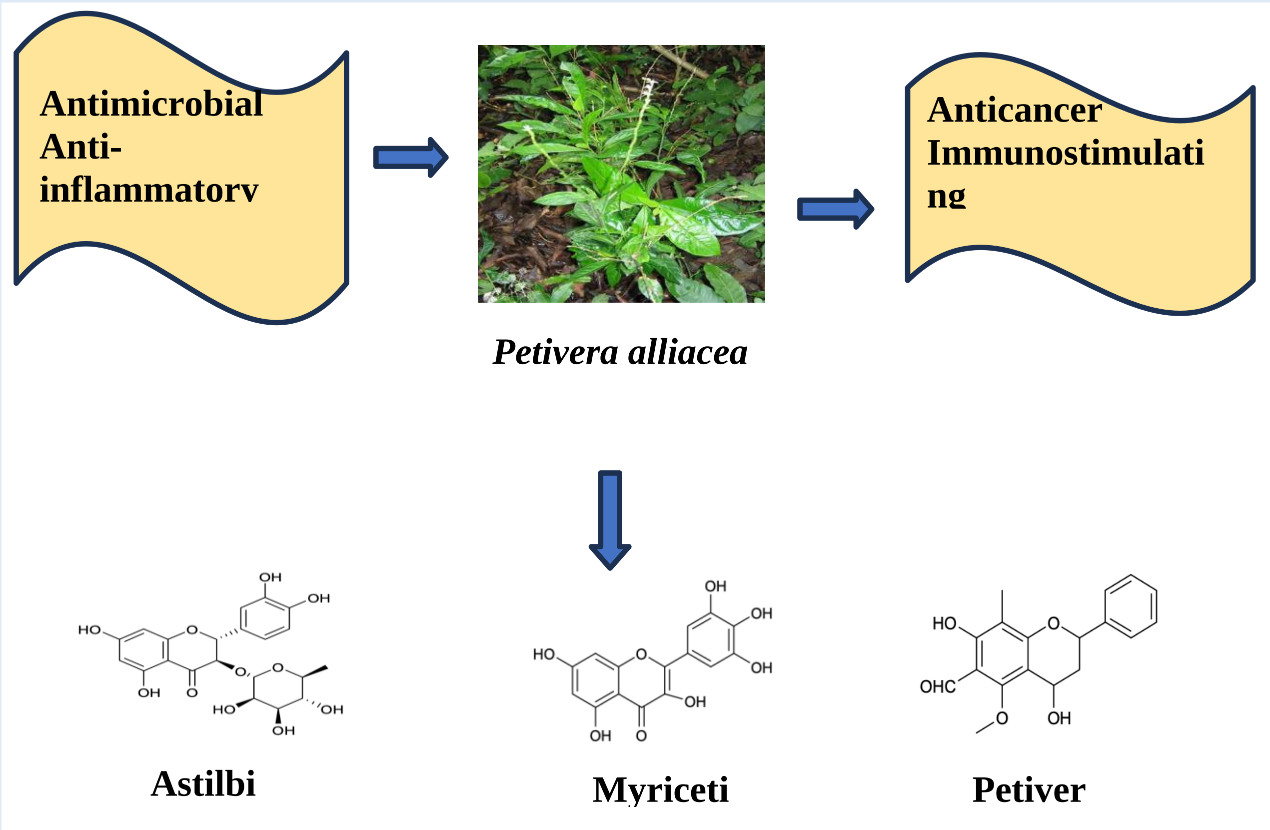
ABSTRACT

Petivera alliacea (Family, Phytolaccaceae) is a wild and perennial shrub used in traditional medicine, especially as an antirheumatic, analgesic, and for various respiratory diseases. There is little comprehensive data on *P. alliacea*'s pharmacological, nutritional, and ethnobotanical characteristics, and it is not in a well-documented form. In the present review, efforts have been made to gather its detailed medicinal uses, chemical composition, and pharmacological properties. The goal of this review is to present an updated summary of documents sourced from recent publications regarding the ethnobotanical importance, pharmacology, toxicological properties, and phytochemistry of *P. alliacea* to further investigate this plant and learn about its potential impact on pharmaceuticals. This literature review used web-based systematic research. PubMed, Google Scholar, Mendeley, and CriticalReview were used to find studies reporting pharmacological, nutritional, and pharmacological properties. The ethnobotanical uses of *P. alliacea* include the treatment of respiratory disorders, fever, venereal diseases, and influenza. The nutritional uses include the use of the powder as herbal concoctions in the form of extracts, teas, and capsules intentionally for boosting immune systems. The reported pharmacological activities are antimicrobial, anti-inflammatory, antidiabetic, anticancer, immunostimulating and antinociceptive activities. Along with flavonoids, steroids, and triterpenes, *P. alliacea* also has sulfur-containing compounds like sulfides, polysulfides, and sulfoxides that make it unique. This review provides detailed information about the history, traditional importance, phytochemistry, and clinical impacts of the studied plant as food and medicine.

Keywords: *Petiveria alliacea*, Traditional medicine, Pharmacological activities, Nutritional importance, Secondary metabolites,



INTRODUCTION

Since the existence of man, numerous ailments have been treated using plants, which are attributed to the various phytochemicals present in them, validating their therapeutic properties. Plants with therapeutic qualities continue to progress, opening new therapeutic avenues for the treatment of various illnesses and contributing to the development of contemporary medications [1]. Recently, health practitioners and medical personnel have shown keen interest in the use of medicinal plants, but the identification of plants, effectiveness, dosage, toxicity levels, standardization, and regularization should be taken seriously [2]. Medicinal plants have been proven to be effective for various pharmacological activities [3-9].

Petiveria alliacea L. is a perennial shrub of the Phytolaccaceae family (Fig. 1). In English, it's called Guinea-Hen weed; among Yoruba-speaking people in Southwest Nigeria, it's called Awogba or Ojusaju; in Hausa, it's known as kanunfari; and in Igbo, it's known as Akwa-Ose [10]. The fruits are narrowly oblong achenes and subtended by persistent bracts and perianth, 6-8 mm long, striate with recurved hooks. The seeds are long, gray, and arrow-shaped [11].

It is native to the rainforest of Amazonia. In addition, *P. alliacea* is found in Africa, the Caribbean, the Southeastern United States, and tropical and central America. Carl Von Linnaeus reported his identification of the plant for the first time in his book Species Plantarum [12]. The wide number of published studies and research has made it possible for researchers and scientists to gather information on plants traditionally and scientifically. This ensures documentation and prevents knowledge from being lost and passed on to generations. This paper thus reviews the medicinal uses, phytochemistry, morphology and ethnobotany, nutritional values, and pharmacological and toxicity properties of *P. alliacea.*

Figure 1. Habitat photograph of *Petivera alliacea L.*

Source: Herb garden, Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria

METHODOLOGY

Search strategy: Between August 2022 and December 2023, a thorough internet search was conducted to find research publications regarding *Petiveria alliacea*. Data was collated from information retrieved from published research papers and various online articles. Web-based systematic research was employed for this literature review. Studies reporting medicinal importance, phytochemistry, nutritional, and pharmacological properties were obtained using PubMed, Google Scholar, Mendeley, and CriticalReview. The following search terms were used to conduct a literature search: *Petiveria alliacea*: medicinal plants and their applications; traditional and medical uses of *P. alliacea*, ethnobotany of *P. alliacea*, pharmacological properties of *P. alliacea,* nutritional values of *P. alliacea,* and isolated compounds from *Petiveria alliacea*.

RESULTS

Ethnobotany and medicinal uses of *Petiveria alliacea*: Traditionally, *P. alliacea* plant parts have been used in various ways, like decoction, infusion, and powder, to treat a wide array of ailments, which include malaria, rheumatism, inflammation, diabetes, arthritis, toothache, and skin infection, amongst others. The various parts of *P. alliacea* have been reported to have a broad variety of medicinal uses, with the roots being recognized as the most active component of the plant and the leaves being used topically and orally in the form of a crude extract [13].

Furthermore, an infusion of the plant parts in alcohol and water exhibits high toxicity levels, which makes it suitable for the treatment of breast cancer and leukemia patients. The pharmacological studies carried out on *P. alliacea* have revealed its therapeutic properties and validated its use as an anticancer, analgesic, antimicrobial, antidiabetic, and antiviral, amongst others [12]. It is also used to boost immunity and promote urination [14]. The positive effects of using this herb to decrease blood sugar levels and eliminate cancer cells have been documented in recent research [15].

In several regions of the world, *P. alliacea* has long been utilized as a restorative herb [10]. It is used to treat respiratory conditions, such as flu and cold symptoms, and to strengthen the immune system. Internal use of the plant has been used to cure a variety of ailments, such as neural spasms, paralysis, hysteria, asthma, whooping cough, pneumonia, bronchitis, hoarseness, fevers, headaches, influenza, cystitis, venereal illnesses, and menstrual disorders [16].

In India, a paste made from *P. alliacea* leaves is externally used as a pain reliever among some indigenous groups. The leaves also produce a liquid that is applied as eye or nasal drops to treat headaches, and sinusitis [17]. It is externally used to treat earaches, fever, and headaches [16]. Also, fresh leaves of *P. alliacea* are placed around the forehead to relieve headaches and earaches by juicing the leaves and applying the liquid straight to the ear [18]. Furthermore, a leaf decoction of *P. alliacea* is used as an analgesic against muscular pain and oedema. It is further used topically as an anti-inflammatory and analgesic for skin conditions [17]. Pounded bark infusion is used internally for the treatment of rheumatism, asthma, syphilis, colic, fever, bronchitis, and cancer. Hysteria, paralysis, asthma, whooping cough, pneumonia, bronchitis, hoarseness, influenza, cystitis, and venereal disease are among the conditions for which the herb is used as a remedy [18], In Guatemala, the plant roots are historically crushed and inhaled as a treatment for sinusitis. Also, in Peru, a leaf infusion is prepared to alleviate symptoms of flu and colds. It is also frequently used in the forests of the Amazon for herbal baths. In addition, the indigenous Garifuna people of Nicaragua utilize a decoction or infusion to treat aches, pains, and colds. In Brazil, it is also reported that *P. alliacea* is used as a natural cure for arthritis, malaria, oedema, and poor memory and as an antispasmodic agent, diuretic, sweat enhancer, and stimulant.

In the event of a difficult birth, macerated leaves are placed in the abdomen to induce contractions [17]. *P. alliacea* is used to induce abortions or to ease labor pains in Central and South America. The whole plant is frequently used in decoctions to reduce fever, ease anxiety, regulate diarrhea, stimulate the uterus, mitigate menstrual conditions, and ease spasms [17]. In Colombia, *P. alliacea* leaves are chewed for tooth coating to prevent dental caries [17]. In the Caribbean, Central America, and Southern Florida, *P. alliacea* is used for restorative and ritual significance, especially in the Santería religion. Traditional healers in Southwest Nigeria have utilized *P. alliacea* to treat sickle cell illness. Based on several pieces of evidence reported on the pharmacological uses of the studied plant species, these applications were further supported by laboratory tests that demonstrated the plant's extracts, at 1.0 and 0.1 mg/mL, to have strong anti-sickling properties [19].

Nutritional, food uses and applications of *Petiveria alliacea*: According to the earlier report on the proximate composition of *Petiveria alliacea,* its leaves and roots contain remarkable amounts of ash, crude fat, crude fiber, dry matter, crude protein, and carbohydrates [20]. The application of dietary and nutraceuticals is preparing the herb in several ways for ingestion, such as a supplement or an ingredient in food or drink preparation. These consist of nutraceutical formulations, smoothies and juices, tinctures and extracts, teas and infusions, culinary applications, salads and dressings, and supplements and extracts. *P. alliaceae*, called Anamu comes in several forms, such as tablets, powders, tinctures, and capsules. This makes it easier to incorporate it into regular eating schedules. Herbal infusions and teas can be made with dried leaves and roots. This makes it possible for it to easily consume healthy substances. It can also be turned into tinctures or liquid extracts that can be added to drinks or eaten on their own [21]. It is occasionally combined into juices or smoothies with fresh fruits or vegetables. This also aids in muffling the strong flavor. *P. alliacea* is utilized as a culinary herb in several cultures. It can bring taste and possibly health benefits to sauces, stews, and soups. Once cut finely, the leaves can be added to salads to give them a taste [21].

P. alliacea leaves are dried and ground into powder, which is used as herbal preparations such as teas, extracts, and capsules purposely to boost the immune system and increase metabolic processes in humans [23]

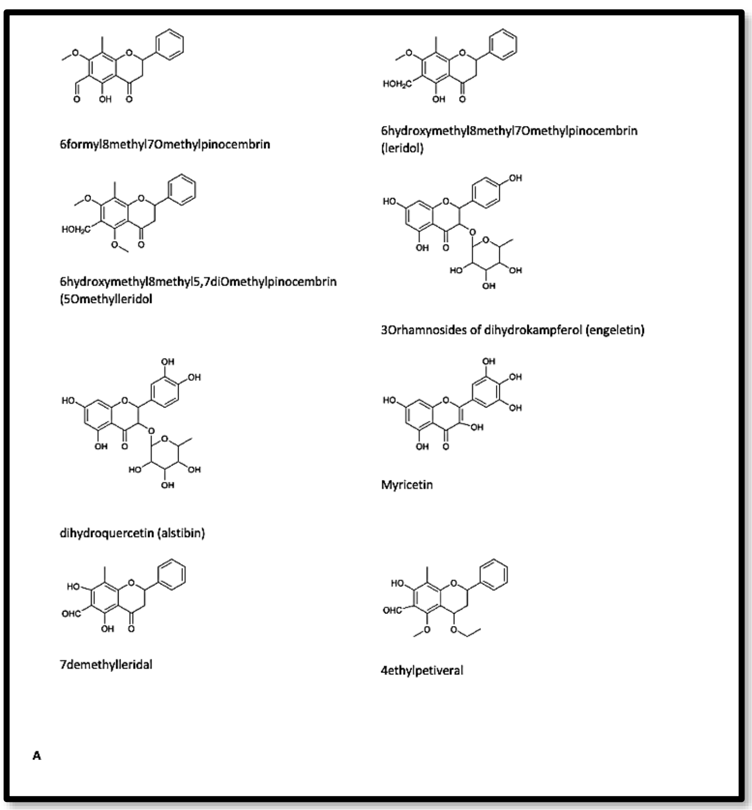
Phytochemistry: Scientists looked at the phytochemicals in *P. alliacea's* leaf, stem bark, and root and found alkaloids, steroids, glycosides, flavonoids, terpenoids, and tannins [22]. *P. alliacea* hexane and methanol fractions and volatile oils were subjected to GC–MS analysis as well as phytochemical component analysis in a different study [23]. Hexane and methanol fractions included alkaloids, saponins, and flavonoids, but not cardiac glycosides, phenols, terpenoids, or anthraquinone glycosides. The *P. alliacea* hexane fraction included 18 compounds, the *P. alliacea* methanol fraction contained 19 compounds, and the volatile oils contained 28 compounds. These findings were obtained using GC-MS analysis [23].

Along with flavonoids, steroids, and triterpenes [10], *P. alliacea* also has sulfur-containing compounds like sulfides, polysulfides, and sulfoxides that make up its chemical profile. There are also some sulfur-containing amino acids in the plant's roots, such as S-benzylcysteine sulfoxides and S-(2-hydroxyethyl) cysteine sulfoxides [24]. There are many chemicals that have been found and reported for *P. alliacea* [25]. These include flavonoids (astilbin, myricitrin, engeletin), triterpenes (barbituric acid, α-friedelinol), steroids (daucosterol), lipids (lignoceric acid, nonadecanoic acid, oleic acid), and other chemicals (allantoin, coumarin). Researchers have effectively extracted several bioactive chemicals from *P. alliacea*, the majority of which are flavonoids, terpenoids, tannins, alkaloids, phytates, phenols, saponins, oxalates, carotenoids, and antioxidants. The compounds that include sulfur are dibenzyl-disulfide and dibenzyl-trisulfide [26]. *P. alliacea* is made up of many different chemicals, including terpenoids, flavonoids [25, 27–28], and higher amounts of organosulfur compounds [24, 29], which give the plant its strong garlic-like smell. An ethanol extract from the aerial parts of *P. alliacea* contained flavonoids and flavonoid derivatives, specifically 6-formyl-8-methyl-5,7-di-O-methylpinocembrin, as well as 3 O rhamnosides of dihydrokampferol, dihydroquercetin, and myricetin [36]. In contrast, the terpenoids in *P. alliacea* are primarily composed of mono and triterpenoids, with the monoterpenes borneol, carvacrol, cumin alcohol, geraniol, geranyl acetate, and palustrol identified in essential oils of root, stems, leaves, and flowers [37]. Polysulfides and thiosulfinates are two sulfur-containing compounds found in *P. alliacea* that are accountable for several biological actions observed in *P. alliacea* extracts [33, 38-40]. Major components recovered from *P.*

alliacea include polysulfides, a family of organosulfur compounds with a broad variety of biological activities.

Dibenzyl trisulfide (DTS), which is the main byproduct of *P. alliacea*, has been shown to stop HIV-1 reverse transcriptase [32]. Additionally, a lipophilic compound identified as one of the immunomodulatory compounds [33] in the plant has been found to exhibit anti-proliferative and cytotoxic activity, where the cytoskeleton is implicated [34]. Dibenzyl trisulfide (DTS) is a compound with several biological activity, including antimicrobial and anticancer properties, that has been isolated from different preparations made from *P. alliacea*, primarily from the roots [31]. The oxidation of cysteinyl disulfides produces thiosulfinates, which are chemicals that are crucial to the redox chemistry of proteins [35]. Because *P. alliacea* ruptures tissues, it irritates the mucous membranes of the nose and eyes, releasing a potent garlic-like odor and lacrimation.

(Z) thiobenzaldehyde S oxide was found to be the compound from the roots that was responsible for this action [36]. Additionally, it was noted that many organosulfur compounds frequently found in *P. alliacea* extracts are the result of thiosulfinates being broken down by enzyme activity following tissue disruption [29]. It has also been demonstrated that the roots of the plant contain derivatives of cysteine sulfoxide that are like but distinct from those found in plants like onion and garlic. *P. alliacea*, for instance, includes S-(2-hydroxyethyl)-L-cysteines (6-hydroxyethiins A and B) and S-phenylmethyl-L-cysteine sulfoxides (petiveriins A and B) [29]. Several thiosulfinates, including S-(2-hydroxyethyl) 2-hydroxyethane) thiosulfinate, S-(2-hydroxylethyl) phenylmethanethiosulfinate, S-benzyl 2-hydroxyethane) thiosulfinate, and S-benzyl phenylmethanethiosulfinate (petivericin) are precursors to these substances [24]. It has been discovered that all four of these thiosulfinates show antimicrobial property [37]. Fig. 2 displays the compounds' chemical structures.



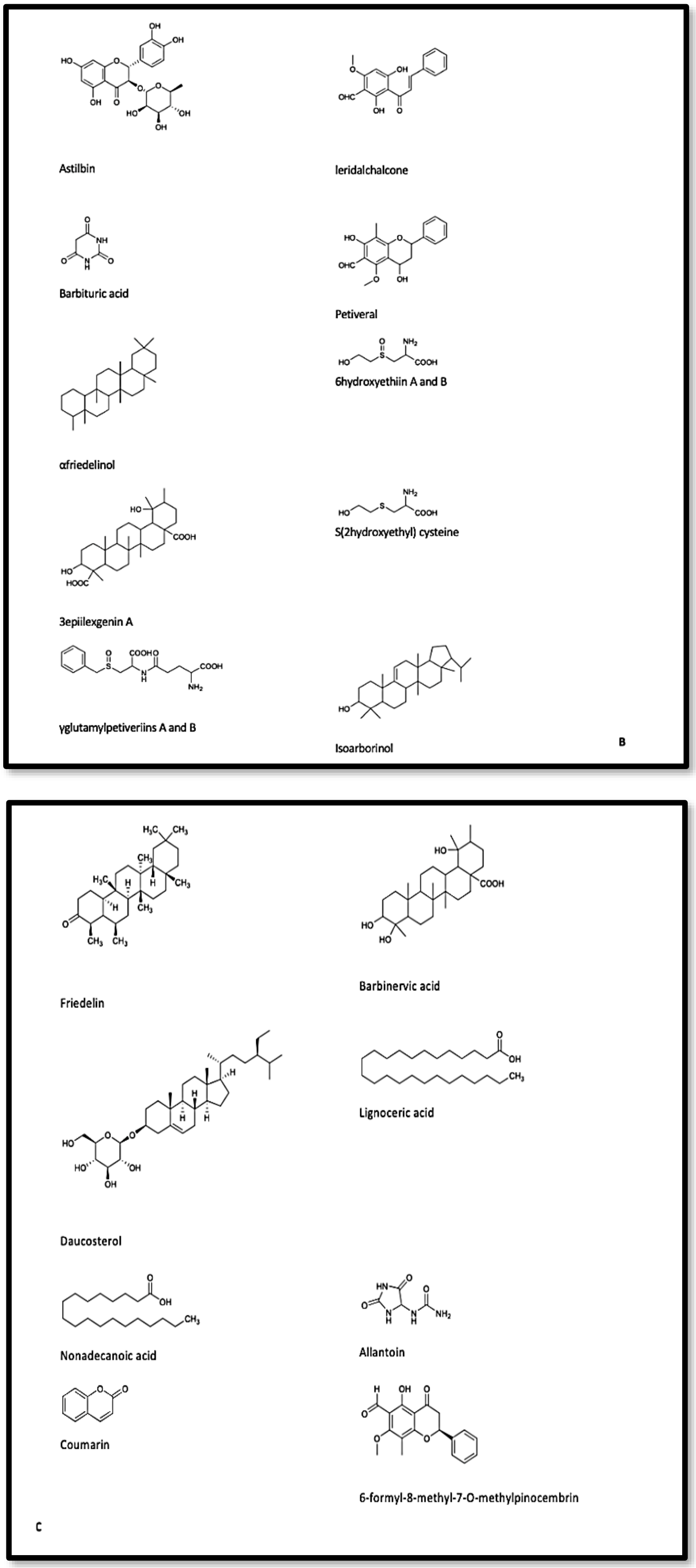


Figure 2. Isolated compounds from *Petivera alliacea*

Pharmacological properties: The pharmacological evaluation of medicinal plants using bioassays has led to the isolation of compounds responsible for these attributes. For several years, researchers have assumed that a single compound is responsible for a plant's biological activity, but recently, considering the possibility of synergy between compounds in a plant has been embraced [38]. Studies have revealed that crude extracts of *P. alliacea* exhibit antisickling [39], fumigant toxicity [40], insecticidal [41], anticancer, antidiabetic, anti-inflammatory, immune stimulant, and antibacterial activities [2].

Antimicrobial activity: The leaf extract inhibited the growth of *Rhizopus sp.* and *Salmonella typhi*, with MIC values of 3.125 µg/mL and MFC values of 6.25 µg/mL, respectively, in the anti-microbial study carried out on *P. alliacea.* Additionally, the leaf extract prevented the development of additional microorganisms like *Aspergillus niger*, *Staphylococcus aureus*, and *Escherichia coli*. Furthermore, the study concluded that all plant parts have utility in treating microorganisms [42]. Furthermore, it has been discovered that other plants belonging to the phytolaccaceae family also exhibit antimicrobial activity [43].

Based on their physical characteristics and cultural characteristics, the endophytic fungal isolates were categorized into 30 morphotypes in a previous study that looked at the endophytic fungal microbiome associated with *P. alliacea*. Fungal endophyte ethyl acetate extract was produced by dividing culture broth liquid to liquid and then evaporating the mixture. The antibacterial activities of the crude extract were tested against two fungal strains (*Aspergillus fumigatus* NRRL 5109) and three bacterial strains (*Escherichia coli* ATTC 25902, *Staphylococcus aureus* ATTC 14775, and *Bacillus subtilis* NRRL 5109). When tested against the indicated bacteria, the crude extracts from endophytes isolated from leaves exhibited antibacterial capabilities in 65 percent of cases [44].

Comparatively, 71 and 88% of the fungal crude extracts from endophytes isolated from the root and stem, respectively, inhibited at least one of the studied bacterial strains. A concentration of 10 mg/mL showed that the crude extracts of ten different fungal isolates blocked both Gram-positive and Gram-negative bacteria in a zone that was more than 12 mm wide. Based on sequencing data from isolates demonstrating strong inhibitory effects, *Fusarium solani*, *Fusarium proliferatum*, and *Fusarium oxysporium* were determined to be the primary endophytes responsible for the bioactive potential. From these results, it seems that *Petiveria alliacea* has fungal endophytes that can make compounds that kill microbes [44]. It is believed that infections are majorly responsible for many cancers and diseases. Traditional medicine has consistently employed *P. alliacea* to treat a wide range of illnesses. Furthermore, the plant has demonstrated antibacterial activities against yeast, bacteria, fungi, and virus strains.

Similar studies were conducted to evaluate *P. alliacea*'s antibacterial and antifungal activity in extracts of the leaves and roots. The findings showed that the antifungal chloroform extracts of the leaves exhibit more efficacy than the antibacterial methanolic extracts of the roots. As an antifungal, the leaf extracts fared better than the root extracts. The researchers investigated the phytochemicals in five different extracts, including aqueous, methanolic, and chloroform extracts of roots, as well as chloroform and methanolic extracts of leaves. These extracts contained alkaloids, saponins, flavonoids, tannins, terpenoids, and steroids. The findings indicated that aqueous extracts, which contain higher phytochemicals than other extracts, are more effective medicinally [45].

Anti-inflammatory activities: Clinical studies have confirmed the traditional use of *P. alliacea* for arthritis and rheumatism validating its pain-relieving and anti-inflammatory effect. Research also has it that the plant has demonstrated COX-1 inhibitory properties, whereas cyclooxygenase-1 inhibitors are well-known and reliable drugs for the treatment of arthritis. Another study on the root extract of *P. alliacea* using different models *in vivo* has proven its anti-inflammatory effects by its significant pain-relieving effect in rats [2].

Antidiabetic activity: This plant has been utilized traditionally in numerous ways in the management of diabetes. Although, limited research has been done to validate this scientifically. Many countries have used this plant in the treatment of diabetes including Cuba and Nigeria. In research to investigate the plant's leaf extracts' inhibitory impact on the alpha-amylase enzyme, *P. alliacea* was compared to the control medication, acrobose. *P. alliacea* demonstrated more alpha-amylase inhibitory capabilities than the control [46]. When the aerial parts of the *P. alliacea* plant were tested for hypoglycemic action in both diabetic and normoglycemic rats, it was found that the plant's aqueous extract only had an impact on hyperglycemic rats and had no effect on normoglycemic rats [47]. When the leaf and stem powder extract was examined *in vivo*, earlier studies found that the mice's blood sugar levels significantly decreased [48].

Anticancer activities: Several studies have been carried out on the anticancer activity of *P. alliaceae* [10, 30, 49]. Research evaluated the antitumor and immunomodulatory activities of *Petiveria alliacea*. Using an MTT experiment, a portion of the plant causes morphological alterations in tumor cell lines without damaging normal human cells [30]. The dose-dependent fraction caused notable alterations in every studied tumor cell line, including elongation and deformation like vincristine. Additionally, the study shows that the fraction of *Petiveria alliacea* has numerous anti-tumoral properties against tumor cells from mice (Mel Rel) and humans (K562, A375).

According to different research, *P. alliacea*-induced 4T1 cell death resulted in caspase-3 activation, DNA fragmentation (without depolarization of the mitochondrial membrane), and a reduction in the cell colony's ability to expand [10]. In BALB/c animals transplanted with GFP-tagged 4T1 cells, the main tumor in the breast also significantly shrank. A fraction of *P. alliacea* used multiple molecular targets to exert its antitumor activities against human (K562, A375) and mouse (Mel Rel) tumour cells [30]. A similar study revealed that DTS and its derivatives exhibited potent anti-proliferation/cytotoxic activity on a wide range of cancer cell lines, to exert its anticancer activity against human (K562, A375) and mouse (Mel Rel) tumour cells, a fraction of *P. alliacea* exploited various molecular targets [30]. A related investigation showed that DTS and its derivatives had strong anti-proliferation and cytotoxic action on a variety of cancer cell lines, also suggesting that *P. alliacea* compounds cause apoptosis only on cancerous cells leaving normal and healthy cells unharmed [38].

Immuno-stimulating properties: The immunostimulant properties of *P. alliacea* have been reported [50]. The plant helps stimulate the immune system by increasing its lymphocyte production and antioxidants. Other natural disease-killing cells such as interferon and interleukins are also produced increasingly thereby helping the immune system to combat cancers and other infections. *P. alliacea* is currently being used in South America to provide aid for cancer and leukaemia patients; this is due to its immune stimulant and anticancerous properties [2, 50].

Toxicological effects: *Petiveria alliacea* has been proven to be toxic in previous research. Studies have revealed that *P. alliacea* causes contraction in pregnant women and so could cause abortion. Additionally, anyone with pre-existing blood disorders should not use the plants as the plant contains a low amount of blood thinner known as Coumadin. Investigations have revealed *P. alliacea* to have a hypoglycemic effect, which should be avoided by diabetic or hypoglycaemic patients [2].

Another toxicological study was carried out on the aqueous suspension from the stems and leaves of this plant. In the repeated dosage research, there were no symptoms of toxicity at 1000 mg/kg. However, the immunomodulatory characteristics of this plant were linked to elevated total leukocyte counts in the male and satellite participants in the trial. The study found that administering *P. alliacea* orally to Sprague Dawley rats resulted in no deaths or had any negative impacts on the rats' general condition, body weights, or histological abnormalities [51].

Antinociceptive activity: Mice were used to evaluate the antinociceptive and toxicological effects of aqueous, hexane, and methanol extracts from *P. alliacea* leaves [52]. Using the formalin model and the different oral doses of each extract, the antinociceptive effect was first investigated to produce the dose-response curves. Acute toxicity was also assessed using serum biochemical analysis and the up-and-down approach. Consequently, all extracts at dosages ranging from 10 to 316 mg/kg were shown to considerably lower pain response in both formalin model phases, with inflammatory response values ranging from 50 to 60%. The toxicological studies revealed that none of the extracts resulted in any deaths up to a dose level of 2000 mg/kg (LD_{50}). This was corroborated by the serum's biochemical characteristics, all of which showed levels within the normal range. In the end, the phytochemical screening verified the existence of phenolic structures (flavonoids, coumarins) and terpenes (saponins and terpenes), with the methanolic extract having the highest lipid content (1.65±0.54 meq diosgenin/mL). These results showed that the *P. alliacea* leaf extract contained antinociceptive compounds [52].

Fumigant toxicity: *Petiveria alliacea* leaf and root bark oil adult *Culex quinquefasciatus* was previously subjected to fumigant toxicity and phytochemical investigation [40]. The leaf extract had a percentage mortality range of 75.00-100% within a 2-hour exposure period ($P<0.05$), and the root bark extract had a mortality range of 81.67-100%. These results show that the *P. alliacea* oil extract, at all concentrations, significantly affected the adult mosquito during fumigant toxicity. The synergistic impact of the leaf and root of the plant was investigated. The amount of leaf, root, and synergistic effect oil extract required to kill 50% of adult *Culex quinquefasciatus* was 0.45 mL, 0.53 mL, and 0.47 mL, respectively, at the lethal concentration (LC_{50}). However, 2.20 mL, 1.194 mL, and 1.15 mL of the leaf, root, and leaf and root oil extract were required to kill 90% (LC_{90}) over a 2-hour exposure period. Results suggested that oil extract from *P. alliacea* might be a dependable source of insecticide to produce biopesticides [40].

CONCLUSION

Petivera alliacea is a medicinal plant with numerous medicinal values. This herb has historically treated various conditions such as headaches, asthma, paralysis, and venereal diseases. The reported pharmacological activities include antimicrobial, anti-inflammatory, antidiabetic, anticancer, and immune stimulating activities. Secondary metabolites previously isolated from this plant include flavonoids, steroids, triterpenoids, tannins, phenols, and alkaloids.

To date, medicinal plants and their derivatives have served as the leading source of new drug discoveries for managing several ailments and disorders. The use of *P. alliacea* in the treatment of cancer cannot be overemphasized, especially due to its selective ability to cause apoptosis in cancer cells, and thus causing no harm to healthy cells. Further research is needed to better understand the synergistic and antagonistic processes of the various chemicals present in the plant.

This review has focused on the significant aspects of *P. alliacea* and may be an addition to other collated data on the species for good documentation and research result analysis. Additionally, researchers should conduct further studies to ensure the drug's safety and determine appropriate dosage administration, considering the previous report on its toxicity.

List of abbreviations: DTS: dibenzyl trisulfide, GC-MS: Gas Chromatography-Mass Spectrometry, MTT: (3- (4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide, DNA: Deoxyribonucleic acid

Competing interests: The authors declare that there are no competing interests.

Authors' contributions: IOL designed the study, performed a literature search, reviewed the manuscript, and gave technical input. MBO performed the literature search and analyzed the collected data. FOA performed the literature search and analyzed the collected data. OYB performed the literature search and analyzed the collected data. LIS wrote the first draft of the manuscript. AEJ wrote the second draft of the manuscript. IAA performed a literature search, reviewed the manuscript, and gave technical input. All authors revised and approved the final manuscript.

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REFERENCES

1. Newman DJ, Cragg GM. Natural products as sources of new drugs over the last 25 years. J Nat Prod 2007, 70:461-477. DOI: https://doi.org/10.1021/np068054v
2. Randle MM, Riley CK, Williams LAD, Watson CT: A Systematic Review of the Traditional and Medicinal Uses of *Petiveria alliacea* L. In the Treatment of Chronic Diseases. J Plant Sci Res 2018, 5(1):179.
3. Babalola OY, Lawal IO, Akinwumi IA: Comparative evaluation of phytochemical, in vitro antioxidant activities and elemental composition of the fruit, leaves, and stem bark of *Tetrapleura tetraptera*. Func Food Sci 2023, 3(12):317-328. DOI: https://www.doi.org/10.31989/ffs.v3i12.1263
4. Babalola YO, Rafiu BO, Olaniyi MB, Sowunmi, LI, Adam AA, Ogunbamowo PO, Ale JE, Akinwumi IA, Lawal IO: Investigation of the phytochemical and elemental constituents of *Euphorbia graminae.* J Chem Soc Nigeria 2023, 48(5):936-948. DOI: https://doi.org/10.46602/jcsn.v48i5.925
5. Ogunlakin AD, Ojo OA, Gyebi GA, Akinwumi IA, Adebodun GO, Ayokunle DI, Ambali OA, Ayeni PO, Awosola OE, Babatunde DE, Akintunde EA, Ajayi-Odoko OA, Dahunsi OS, Sonibare MA: Elemental evaluation, nutritional analysis, GC-MS analysis and ameliorative effects of *Artocarpus communis* J.R.Forst. and G.Forst. seeds' phytoconstituents on metabolic syndrome *via* in silico approach. J Biomol Struc Dyn. 2023. DOI: https://doi.org/10.1080/07391102.2023.2293271
6. Akinwumi IA, Sonibare MA, Khan M: *In vitro* anti-ulcer activity and isolation of 5-Hydroxymethyl furan-2-carbaldehyde and palmatine from *Curculigo pilosa* (Schumach. and Thonn.) Engl. Nig J Nat Prod Med. 2022a.
7. Akinwumi IA, Sonibare MA, Salami AT: Gastroprotective Effect of Methanol extracts of *Sphenocentrum jollyanum* Pierre and *Curculigo pilosa* (Schumach. and Thonn.) Engl. in

Wistar Rats. Trop J Nat Prod Res 2022b, 6(4):637-644. DOI: https://doi.org/10.26538/tjnpr/v6i4.27

8. Akinwumi IA, Ambali OA: Traditional knowledge of cancer treatment in Southwestern Nigeria: An ethnopharmacological review. J Chem Soc Nig 2023, 48(5): 845-870.
9. Akinwumi IA, Sonibare MA, Yeye EO, Khan M: Bioassay-guided isolation and identification of anti-ulcer ecdysteroids from the seeds of *Sphenocentrum jollyanum* Pierre (Menispermaceae). 2020. DOI: https://doi.org/10.1016/j.steroids.2020.108636
10. Olomieja AO, Olanrewaju IO, Ayo-Ajayi JI, Jolayemi GE, Daniel UO, Mordi RC: Antimicrobial and Antioxidant properties of *Petiveria alliacea*. IOP Conf. Ser.: Earth Environ. Sci 2021, 655 012015. DOI: https://doi.org/10.1088/1755-1315/655/1/012015
11. Alegre, J.C., Clavo, M. 2007. *Petiveria alliacea* L. Plant resources of tropical Africa. https://www.prota4u.org/database/protav8
12. Silva JPB, Martins do Nascimentos S, Okabe D, Pinto AG, Olivera F, Paxao TP, Siqueria M: Antimicrobial and anticancer potential of *Petiveria alliacea* L. (Herb to "Tame the Master"): A review. Pharm Rev 2018, 12(23):85. DOI: https://doi.org/10.4103/phrev.phrev_50_17
13. Lopes-Martins RAB, Pegoraro DH, Woisky R, Penna SC, Sertie JAA: The anti-inflammatory and analgesic effects of a crude extract of *Petiveria alliacea* L. (Phytolaccaceae), Phytomed 2002, 9:245-248. DOI: https://doi.org/10.1078/0944-7113-00118
14. CABI (2020) *Petiveria alliacea* (guinea hen weed) [original text by Rojas-Sandoval J, Acevedo-Rodriguez P]. In: Invasive Species Compendium. Wallingford, UK: CAB International. Accessed 12 January 2020 [https://www.cabi.org/isc/datasheet/70236]. Retrieved on February 27th, 2024.
15. Tropical Plant Database: Anamu (*Petiveria alliacea*)" Raintree. 2013-02-11. Retrieved 2017-01-06.
16. Brown D: Encyclopaedia of herbs and their uses. Dorling Kindersley 1995, pp:424.
17. Gentry A: A Field Guide to the Families and Genera of Woody Plants of Northwest South America (Colombia, Ecuador, Peru). Illustrations by R. Vasquez Martinez. Conservation International. Washington, DC 1993.
18. Hernandez JF, Uruena CP, Cifuentes MC, Sandoval TA, Pombo LM, Castaneda D, Asea A, Fiorentino SA: *Petiveria alliacea* standardized fraction induces breast adenocarcinoma cell death by modulating glycolytic metabolism. J ethnopharmacol 2014, 153(3):641-649. DOI: https://doi.org/10.1016/j.jep.2014.03.013
19. Adejumo OE, Owa-Agbanah IS, Kolapo AL, Marcus A: Phytochemical and antisickling activities of *Entandrophragma utile*, *Chenopodium ambrosioides* and *Petiveria alliacea*. J Med Plants Res 2011, 5:1531-1535.
20. Sobayo RA, Okonkwo IJ, Sanwo KA, Oso OA, Eruvbetine D, Oguntona EB, Muhammed SB: Effect of dietary supplementation of guinea hen weed (*Petiveria alliacea*) leaf and root meals on nutrient utilization and intestinal morphology of finishing broiler chicken. Nig J Anim Sci 2017, (1):144–156.
21. DeCaria S: Anamu (*Petiveria alliacea*): Traditional Uses, Health Benefits, and Conservation. [https://www.epainassist.com/diet-and-nutrition/anamu-petiveria-alliacea]. Retrieved on February 27th, 2024.
22. Arogbodo JO, Igbe FO, Osho IB, Adebayo IA: Processing yield percentage and phytochemical appraisement of the leaf, stem-bark, inflore-infructescence, and root of *Petiveria alliacea* (Linneaus). Int J Sci Res Biol Sci 2021, 8(1):65-70
23. Adesanya EO, Oyesiku OO, Adesanya OO, Ogunlakin AD, Odugbemi AI, Egieyeh S: Phytochemical components and GC–MS analysis of *Petiveria alliacea* L. fractions and volatile oils. Phys Sci Rev 2023. DOI: https://doi.org/10.1515/psr-2022-0311
24. Kubec R, Kim S, Musah RA: S-Substituted cysteine derivatives and thiosulfinate formation in *Petiveria alliacea*. Part II. Phytochem 2002, 61:675–680. DOI: https://doi.org/10.1016/s0031-9422(02)00328-x
25. Delle-Monache F, Cuca-Suarez LE: 6-C-formyl and 6-Chydroxymethyl flavanones from *Petiveria alliacea* and Atlantic Forest. 2nd ed. São Paulo: Editora Unesp 1992, p. 14973.
26. Ekunseitan DA, Yusuf AO, Olayinka OA, Ayoola A, Adedotun A: Comparative study of two plants (*Lagenaria breviflora* and *Petiveria alliacea*) and their phytobiotic potential in poultry health. Nig J Anim Prod 2016, 43:289–298.
27. Delle-Monache F, Menichini F, Cuca-Suarez LE: *Petiveria alliacea*. Part 2. Further flavonoids and triterpenes. Gazz

Chim Ital 1996, 126:275-278. DOI: https://doi.org/10.1002/chin.199637256

28. Neves IA, Camara CAG, Oliveira JCS, Almeida AV: Acaricidal activity and essential oil composition of *Petiveria alliacea* L. from Pernambuco (northeast Brazil). J Essent Oil Res 2011, 23(1):23-26. DOI: https://doi.org/10.1080/10412905.2011.9700426
29. Kubec R, Musah RA: Cysteine sulfoxide derivatives in *Petiveria alliacea*, Phytochem 2001,58:981-985. DOI: https://doi.org/10.1016/s0031-9422(01)00304-1
30. Uruena C, Cifuentes C, Castaneda D, Arango A, Kaur P, Asea A, Fiorentino S: *Petiveria alliacea* extracts uses multiple mechanisms to inhibit growth of human and mouse tumoral cells. BMC Complement Altern Med 2008, 8:60. DOI: https://doi.org/10.1186/1472-6882-8-60
31. Rosado-Aguilar JA, Aguilar-Caballero A, Rodriguez-Vivas RI, BorgesArgaez R, Garcia-Vazquez Z, Mendez-Gonzalez M: Acaricidal activity of extracts from *Petiveria alliacea* (Phytolaccaceae) against the cattle tick, Rhipicephalus (Boophilus) microplus (Acari: ixodidae). Vet. Parasitol. 2010, 168:299-303. DOI: https://doi.org/10.1016/j.vetpar.2009.11.022
32. Lowe HIC, Toyang NJ, Heredia A, Ayeah, KNN, Watson CT, Bryant J: *Petiveria alliacea* L (Guinea Hen Weed) and its major metabolite dibenzyl trisulfide demonstrate HIV-1 reverse transcriptase inhibitory activity. Eur J Med Plants 2015, 5(1):88-94. DOI: https://doi.org/10.9734/EJMP/2015/12064
33. Rosner H, Williams LA, Jung A, Kraus W: Disassembly of microtubules and inhibition of neurite outgrowth, neuroblastoma cell proliferation, and MAP kinase tyrosine dephosphorylation by dibenzyl trisulphide. Biochim Biophys Acta 2001, 1540:166-77. DOI: https://doi.org/10.1016/S0167-4889(01)00129-X
34. Williams LA, Rosner H, Levy HG, Barton EN: A critical review of the therapeutic potential of dibenzyl trisulphide isolated from *Petiveria alliacea* L (guinea hen weed, anamu). West Indian Med J 2007, 56:17-21.
35. Amorati R, Lynett PT, Valgimigli L, Pratt DA: The reaction of sulfenic acids with peroxyl radicals: Insights into the radicaltrapping antioxidant activity of plant-derived thiosulfinates. Chemistry 2012, 18:63706379. DOI: https://doi.org/10.1002/chem.201103459
36. Santander SP, Uruena C, Castaneda D, Cifuentes C, Aristizabal F, Cordero C: Influencia del tratamiento de *Petiveria alliacea* en la expression differential de genes en células tumorales. Rev Univ Med 2010, 50:28496.
37. Kim S, Kubec R, Musah RA: "Antibacterial and antifungal activity of sulfur-containing compounds from *Petiveria alliacea*" (PDF). J Ethnopharmacol 2006, 104:188–192. DOI: https://doi.org/10.1016/j.jep.2005.08.072
38. Williamson EM: Synergy and other interactions in phytomedicines. Phytomed 2001, 8:401-9. DOI: https://doi.org/10.1078/0944-7113-00060
39. Iyekowa O, Okieimen FE, Ehisuoria CO: *In-vitro* antisickling activity of *Pergularia daemia*, *Canna indica* and *Petiveria alliacea* plants used in the treatment of sickle cell anaemia in Edo State, Nigeria. Tanzania J Sci 2023, 49(2):433-445.
40. Akintan MO, Akinneye JO, Ilelakinwa OB: Efficacy of *Petiveria alliacea* (Linneaus) leaf and root bark powder in controlling filariasis vector *Culex quinquefasciatus*. The J Basic Appl Zool 2021, 82:5. DOI: https://doi.org/10.1186/s41936-020-00199-3
41. Akintan MO, Akinneye JO: Fumigant toxicity and phytochemical analysis of *Petiveria alliacea* (Linneaus) leaf and root bark oil on adult *Culex quinquefasciatus*. Bull Nat Res Cent 2020, 44:129. DOI: https://doi.org/10.1186/s42269-020-00355-3
42. Olomieja AO, Jolayemi GE, Owolabi FE, Mordi RC: Chemical Components and Antimicrobial Activity of Essential Oils of *Petiveria alliacea* Leaves Extracts Arch Ecotoxicol 2020, 2(3):47-50. DOI: https://doi.org/10.36547/ae.2020.2.3.47-50
43. Sydor BG, Ramos-Milare ACFH, Pereira MB, Brustolin AA, Montaholi DC, Lera-Nonose DSSL, Negri M, de Lima Scodro RB, Teixeira JJV, Lonardoni MVC: Plants of the Phytolaccaceae family with antimicrobial activity: A systematic review. Phytother Res 2022, 3505-3528. DOI: https://doi.org/10.1002/ptr.7557
44. Khadka G, Annamalai T, Shetty KG, Tse-Dinh YC, Jayachandran K: Isolation and characterization of fungal endophytes from *Petiveria alliacea* and their antimicrobial activities in South Florida. Microbiol Res 2023, 14:1470-1482. DOI: https://doi.org/10.3390/ microbiolres14030100
45. Gbenga OD, Oluyemi OO: Antifungal, antibacterial and phytochemical properties of *Petiveria alliacea* plant from Iwo, Nigeria". Chem Res J 2019, 4(1):12–18
46. Akoro S, Omotayo M, Ajibaye S, Dada F: Comparative Alpha-amylase inhibitory properties of the leaf extracts of *Petiveria alliacea* L. Chem Sci Int J 2017, 19:1-9. DOI: https://doi.org/10.9734/CSJI/2017/32528

47. Christie SL, Levy A: Evaluation of the hypoglycaemic activity of *Petiveria alliacea* (Guinea Hen Weed) extracts in normoglycaemic and diabetic rat models. West Indian Med J 2013, 62:685-691
48. Schmelzer G, Gurib-Fakim A, Medicinal Plants. Plant Resources of Tropical Africa. 2008, pp: 412-415.
49. Murillo N, Lasso P, Uruena C, Pardo-Rodriguez D, Ballesteros-Ramirez R, Betancourt G, Rojas L, Cala MP, Fiorentino S: *Petiveria alliacea* Reduces Tumor Burden and Metastasis and Regulates the Peripheral Immune Response in a Murine Myeloid Leukemia Model. Int J Mol Sci 2023, 24:12972. DOI: https://doi.org/10.3390/ ijms24161297
50. Rodrıguez Z, Garcia-Perez ME, Batista-Duharte A: The anamu tablet: an immunostimulant herbal medicine. MEDISAN 2004, 8:57-64.
51. Garcia-Perez ME, Alfonso-Castillo A, Loresb OF, Batista-Duharte A, Lemus-Rodrigue Z: Toxicological evaluation of an aqueous suspension from leaves and stems of *Petiveria alliacea* L. (Phytolaccaceae). J Ethnopharmacol 2018, 211:29-37. DOI: https://doi.org/10.1016/j.jep.2017.09.022
52. Cruz-Salomon KDC, Cruz-Rodríguez RI, Espinosa-Juarez JV, Cruz-Salomon A, Briones-Aranda, A, Ruiz-Lau N, Ruiz-Valdiviezo VM: *In vivo* and in silico study of the antinociceptive and toxicological effect of the extracts of *Petiveria alliacea* L. Leaves. Pharmaceuticals 2022, 15:943. DOI: https://doi.org/10.3390/ph15080943