ABSTRACT

Introduction: Snakebites are a serious public health concern due to their high morbidity and mortality. Most of the snake venoms produce intense local tissue damage which could lead to temporary or permanent disability in victims. Complementary and alternative medicine for snakebite treatment has been widely explored. This review is aimed at providing an updated overview of medicinal plants implicated as antiphidian agents in Nigeria.

Methods: A review of publications on anti-snake venom activity of Nigerian-grown plants from 1992 to 2020 was undertaken using different scientific sources and databases.

Results: In all, 20 scientifically-investigated plants which belonged to 20 genera occurring in 16 families were documented. Plants from mainly Fabaceae (20%) and Annonaceae (10%) topped the list of studied families. The predominantly investigated morphological parts were the leaf (47.4%), stem bark (21.1%) and root bark (10.5%). In vivo and in vitro laboratory investigations conducted focussed mainly on Naja nigricollis envenomation (46.3%), moderately on Bitis arietans (19.5%), Echis ocellatus (14.6%) and Echis carinatus (12.2%), and to a lesser extent on Naja melanoleuca (4.9%) and Calloselasma rhodostoma (2.4%) snakes. The most researched anti-snake venom plant in Nigeria was Mucuna pruriens (15.3%) followed by Annona senegalensis (11.5%) and Crinum jagus (7.7%). Isolated antivenom compounds included the phenolic resveratrol, the alkaloid aristolochic acid, flavonoids-\(O\)-glycosides, schumanniofoside (a chromone alkaloidal glycoside) and an unidentified glycoprotein.

Conclusion: This review has unravelled possibly efficacious folkloric anti-snake venom plants growing in Nigeria which will provide raw material base for the local industries in the manufacture and development of marketable antiophidian drugs to combat the high incidence of snakebites.

Keywords: Annona senegalensis Pers, Anti-snake venom activity, antivenom compounds, Fabaceae, Mucuna pruriens L., Naja nigricollis Hallowel snake, Nigeria

INTRODUCTION

Snakebites represent a public health hazard that leads to high morbidity and mortality especially in the African continent and Indian subcontinent. The presence of more species of dangerous snakes and inaccessibility of immediate medical treatment are some of the contributing factors to high prevalence of snake bites. It is responsible for over 100,000 deaths and maims more than 400,000 people globally every year. Snakes with major clinical importance belong to the families Elapidae (African and Asian cobras, Asian kraits, African mambas, American coral snakes, Australian and New Guinean venomous snakes, and sea snakes) and Viperidae (Old World vipers, American rattlesnakes and pit vipers, and Asian pit vipers). It is estimated that the number of global ophidic accidents attains about one million, resulting in 600,000 envenomations and more than 20,000 deaths annually. Other sources recorded annual...
global incidences of 5 million with about 40,000 or more deaths. Various factors affecting snake bite mortality due to mainly *Echis ocellatus* (1.41%), and with reference to a village in north eastern Nigeria have been enumerated to include non-availability of antivenom and delay from bite to hospitalization among others. This mortality rate was similar to that found in northern Ghana.

Antiserum is the only therapeutic agent available throughout the world. Snake venoms are complex mixture of enzymatic and toxic proteins, which include phospholipase A$_2$ (PLA$_2$), myotoxins, hemorrhagic metalloproteinases and other proteolytic enzymes, coagulant components, cardiotoxins, cytotoxins and neurotoxins. However, limited availability and accessibility of anti-snake venoms has been recorded in Sub-Saharan Africa, Asia, and, to a lesser extent, Latin America. Traditional herbal medicine is readily available in rural areas for the treatment of snakebite. Plants are used either singly or in combination, as antidotes for snake envenomation by rural populations in Nigeria and in other parts of the world, and are reputed to neutralize the toxicity of snake venom, with a compendia of plants claimed to be antidotes for snakebites in folk medicines already published. This review is an attempt to focus on the plant-based treatment of snakebites in Nigeria, using information related to ethnopharmacology, and *in vivo* and *in vitro* experimental models. Therefore, this current review forms an important addendum to the database of relevant medicinal plants implicated in antiophidian episodes in Africa.

Nigeria, with a population of 207,208,375 is a multilingual country home to a diverse culture with a rich and glorious heritage. Nigeria’s land border covers 920,000 sq km and is shared with neighbouring countries, including Niger Republic to the north, Chad Republic to the north east, Cameroon Republic to the east and Benin Republic to the west (Fig 1). Nigeria is very rich in biodiversity which have demonstrated significant medicinal properties.

**Methods**

An extensive review of the literature from different scientific sources including “Google”, “Google scholar” and “Pubmed” was conducted using keywords such as “anti-snake venom activity,” “antiophidian plants”, “anti-snake activity”, “ethno botany,” “Nigerian,” “medicinal plants” and “snake bite”. The study databases included original articles published in peer-reviewed journals, books, and a PhD thesis and other reports providing information on plants used in the treatment of snakebite. The summaries of published articles emphasising mainly: botanical source (s), family, local name (s), part (s) used, investigated anti-snake activity, bioactive compounds and reference (s) were considered, and presented in Table 1.

**Prevalence of snake bites in Nigeria**

Envenomation, especially by snakebite, is a serious world-wide public health crisis, especially in tropical and sub-tropical countries like Nigeria. Inappropriate and unwarranted treatment results from reasons such as the failure to identify the snake species (venomous or non-venomous), which increases the risk of complications, delay in reporting cases of snake bites and ignorance on the part of victims. Envenomation is a reaction by snakes. Their bite is a natural protective defence mechanism.

WHO reports that 174 snake bites per 100,000 population occur in Nigeria yearly and that the saw-scaled or carpet viper (*Echis ocellatus*) is responsible for 90% of bites. Four families of venomous snakes found in Nigeria include Viperidae, Elapidae, Colubridae and Actraspidae, but three species, carpet viper (*Echis ocellatus* Stemmler), black-necked spitting cobra (*Naja nigricollis* Hallowel) and puff adder (*Bitis arietans* Merrem) belonging to the first two families are the most important snakes associated with envenomation in Nigeria. The Benue valley in Nigeria is predominant for most of these tragedies where prevalence of 497 bites per 100,000 persons per year, and mortality rate of 12.2% are reported, with *Echis ocellatus* accounting for about 66%.
among hospitalized Nigerian children (age range 1-14 years) during the rainy season in Enugu (prevalence of 0.25%) in the Southeast\textsuperscript{13} and Sokoto\textsuperscript{14} (1.5 /1000) in the Northwest have been published. Taraba state has been reported to have one of the high annual incidence (40.4% bites) in the country\textsuperscript{6}. Prevalence of snakebites around the world has been reviewed\textsuperscript{15}.

Incidences of snake bites, a major problem in the rural communities of Nigeria, are commonly recorded in the Middle belt region comprising Gombe, Benue, Plateau and Taraba states (with the highest prevalence), Kwara, Kogi, Kaduna and Enugu states (with low prevalence)\textsuperscript{6,12,16} (Fig. 1). Farmers were observed to be more vulnerable to snake bites especially in the rainy season as an occupational hazard. As regards site of snake bite, Ademola-Majekodunmi\textsuperscript{16} and Malik \textit{et al}\textsuperscript{12} found that majority of the victims (68 - 82%) within the age range of 21 - 30 years were bitten in their legs, while 18% were bitten in their hands in Nigeria. Omogbai \textit{et al}\textsuperscript{17} also recorded similar observation on the site of snake bites in hospitalized patients in Benin City, Nigeria.

The male population was the predominant snakebite victim in Nigeria.\textsuperscript{12,16} They also reported that most snake bites originating from \textit{Bitis arietans} occurred in the evening and during rainy season. Furthermore, Omogbai \textit{et al}\textsuperscript{17} reported that 59.5% of snake bite cases (435/ 1050 total patients) admitted into the University Teaching hospital during a twenty-year period originated from victims dwelling in the rural areas in Benin City, South of Nigeria, and they were mostly youthful population. Furthermore, 25 snake bite victims out of 5,375 (prevalence of 4.65/ 1000) hospitalized patients in a two and half year survey in Gusau, Zamfara state in Nigeria was published\textsuperscript{18}. The snake bite victims were mostly children (68%).

\textbf{Figure 1:} Map of Nigeria showing prevalence of snakebite
Folkloric anti-snake venom plants in Nigeria
In Nigeria, limited ethnopharmacological surveys of anti-snake venom plants has been undertaken. Ameen et al. reported prominent anti-snake venom families in Taraba state in northern Nigeria as: Asteraceae, Liliaceae, Malvaceae and Mimosaceae. These were observed to be different from those of other African countries but slight semblance to the Indian traditional recipes. Review of ethnobotanical surveys of folkloric antivenom plants in many parts of the world has been documented. Previously, Binorkar and Jani have documented a profile of 258 folkloric anti-snake venom plants in developing countries administered in the form of infusion, paste, poultice, juice, latex, extract, and orally in most cases.

In Nigeria, only the ethnomedicinal survey of Taraba state and two epidemiological surveys from Benue and Gombe states, are available for snake bites treatment. Nineteen prominent folkloric anti-snake plants mainly Annona senegalensis, Acacia senegal, Aspilia africana, Hibiscus sabdariffa and Securidaca longipedunculata were used by the herdsmen in Taraba state of Nigeria. The Indian subcontinent is the home of many ethnopharmacological surveys and scientifically studied antivenom plants. About 300 traditional anti-snake venom recipes prepared primarily and sequentially from the roots, leaves and whole plants (13-28%) are usually administered orally as infusion, decoction, juices and powders, and topically as paste for external applications, 205 for internal applications, and 261 for both internal and external uses. The use of medicinal plants for snake envenomation has been influenced by inadequacy of healthcare system, and due to its cost effectiveness and cultural acceptability.

“Anti-snake venom activities relative to Nigerian plants”
Active research into folkloric antivenom plants has become widely acceptable among scientists, and recently, Gomez-Betancur et al. reviewed global ethnopharmacological and scientific studies on antivenom plants including Nigeria. The anti-snake venom activities of 20 scientifically investigated Nigerian medicinal plants which belonged mainly to Fabaceae and Annonaceae are summarized in Table 1. In vivo assays were mostly adopted in 85% of these investigations, and only six plants were fully investigated by both in vivo and in vitro assays. Morphological parts in the sequence: leaf (47.82%), stem bark (17.39%) and root bark (13.04%) are predominantly investigated (Fig. 3). Others were root=rhizome=bulb=aerial parts=seed= 4.34% each. In vivo and in vitro envenomations were documented as follows: Naja nigricollis (46.3%), Bitis arietans (19.5%), Echis ocellatus (14.6%), Echis carinatus (12.2%).
Based on the number of research publications, the most researched anti-snake venom plants in Nigeria were *Mucuna pruriens* (15.3%), *Annona senegalensis* (11.5%) and *Crinum jagus* (7.7%). Only *Annona senegalensis* was scientifically validated among the five prominent anti-snake venom plants in the Taraba state ethnobotanical survey. Other workers have published research activities on 19 Indian medicinal plants used for treating snake bites including *Crinum jagus* and *Parkia biglobosa* also occurring in Nigeria. Bioactive anti-snake venom compounds in Nigerian plants

The classes of bioactive antivenom compounds include flavonoids, phenolic compounds, terpenes, steroids and to a lesser extent organic acids and alkaloids. Apart from *Bryophyllum pinnatum*, *Schumanniophyton magnificum*, *Mucuna pruriens*, *Annona* species, *Aristolochia* species and *Crinum jagus* (Table 1), active antivenom compounds from Nigerian medicinal plants are seldom reported. Figure 4 lists available bioactive antivenom compounds from Nigerian plants such as resveratrol, a phenolic compound with PLA₂ and hyaluronidase activities from *Crinum jagus* and aristolochic acid, analkaloid with similar activities occurring in *Aristolochia* species. From *Annona* species, Gomez-Betancur et al. listed cabenegrins A-I and A-II (phenolic terocarpsans) with activity both in vivo and in vitro as bioactive compounds. Flavonoids-O-glycoside sides have been isolated as bioactive antivenom agents in the hydroethanolic leaf extracts of *Bryophyllum pinnatum* by HPLC-DAD-MS and HPLC-DAD-MS/MS. They include patuletin-3-O-glycoside, patuletin-3-O-α-L-rhamnopyranosyl-7-O-α-L-rhamnopyranoside, and glycosylated flavonoid derivative of quercetin, quercitrin. Some aglycones identified were eupafolin and kaempferol. A high inhibition of venom hyaluronidases was reported for kaempferol and quercetin among other flavonol aglycones. Flavonoids possess a wide array of health benefits and are beneficial in treating various ailments. A peptide compound possessing anticardiototoxic activity against cobra venom was isolated from *Schumanniophyton magnificum*. Furthermore, the methanol extract of the stem bark yielded schumannioside, a chromone alkaloaid glycoside which reduced the lethal effect of black cobra (*Naja melanoleuca*) venom in mice. Maximal effect was produced when schumannioside preincubated with venom was used. A multiformal glycoprotein which neutralized *Echis carinatus* venom-induced toxicity was isolated from *Mucuna pruriens* seeds.

Considering the limitation of low efficacy/potency of plant remedies in neutralizing the venom toxicity, a combined approach that includes both herbal and conventional anti-snake venom therapies will be helpful in ineffective management of snake venom-induced complications.
**Figure 3:** Distribution of plant parts in anti-snake venom investigation

- Resveratrol
- Eupafolin
- Aristolochic acid
- Cabenegrin A-II
- Quercetin
- Cabenegrin A-I
- Kaempferol
- Patuletin
- Schumanniofoside
Mechanisms of action of bioactive antivenom compounds

Various mechanisms by which snake venom neutralization occur have been described. They include protein precipitation, enzyme activation, chelation, antioxidant (by vitamins A, C and E, flavonoids, polyphenols, tannins, terpenoids which prevent or reduce oxidative damage due to PLA₂ activity by selectively binding to the active sites), and protein folding. Active plant extracts or compounds elicit inactivation of snake venom enzymes such as PLA₂, hyaluronidases and metalloproteases by a non-specific interaction leading to formation of a stable complex. Pereanez et al. have described a correlation between antioxidant and anti-snake venom activities, which was suggested to account for the higher inhibition of platelet aggregation observed for the aqueous fraction of Bryophyllum pinnatum against tested venoms in vitro.

Phenolics, specifically polyphenols were suggested to elicit anti-venom activity by acting upon components of venom without delay and preventing them from eliciting toxicity on their victims. Inhibitory effectiveness of phenolic compounds on PLAs has been studied by molecular modelling. Flavonoid glycosides act by modulating key cellular enzyme functions and consequently are active against many snake venoms. For example, apigenin, kaempferol, quercetin and myricetin display high inhibition of venom hyaluronidases, while kaempferol and quercetin in addition also exhibit PLA₂ and lipoxygenase activities. Mode of action of schumannioside is suggested to involve oxidative inactivation of the venom. Tan et al. postulated immunological neutralizations as a possible mechanism of action by plant extracts.

Clinically-useful antivenom compounds and current best practices in treating snake bites

The use of plant-based remedies in the treatment of snakebites on a global scale is an emerging therapy.
Most often, treatment of ophidic accidents is restricted to the use of conventional methods published by WHO. Parenteral administration of animal-derived anti-snake venoms represents the mainstay in the treatment of snakebite envenomings. Commercial anti-snake venoms which comprise the polyvalent and monovalent immunoglobulins have been widely accepted for effectiveness. Three FDA-approved Anti Snake Venoms (ASV)- Antivenin® Wyeth (equine), Crofab® (Crotalidae polyvalent immune (ovine) and Anavip® (Crotalidae immune F (ab) equine are currently in use in the USA for snakebite treatment. In many countries, production and manufacture of antivenoms are managed by governmental agencies or laboratories. The Commonwealth Serum Laboratories have produced mono- and polyvalent snake antivenoms for the most dangerous snakes in Australia.

In Nigeria, EchiTab-G® Anti Snake Venom (ASV) (monospecific against Echis ocellatus) and EchiTab-Plus-ICP® manufactured by MicroPharm Limited, UK are the approved clinical therapies for snakebites. These ASVs which are specific for Echis ocellatus resulted in a Case Fatality Ratio of 1.52% was found to be more effective than other ASVs as only one dose was required to clear the venom from a victim. In addition, a polyspecific Pan-African antivenom has been developed from the plasma of horses immunized with a mixture of the three medically important snakes in sub-Saharan Africa, Echis ocellatus, Bitis arietans and Naja nigricollis.

A comparative protocol for the treatment of snakebite has been published. The authors believe the Haddad protocol seems to be the best method of snake bite treatment as it causes least important complications (deformity, compartment syndrome needing fasciotomy, and amputation) and even less serum sickness in comparison with the other two protocols. The protocol generally prescribes more doses for mild, moderate, and severe envenomations which exceeds the vials recommended by Goldfrank's Toxicologic Emergencies (GTE) and WHO.

CONCLUSION
This review represents the first attempt at documenting in detail the scientifically-investigated anti-snake venom plants in Nigeria which focussed mainly on Naja nigricollis, Bitis arietans and Echis ocellatus snakes. Of the 20 medicinal plants covered in this review, only three- Mucuna pruriens, Annona senegalensis and Crinum jagus were the most frequently investigated. Lack of information on anti-snake families in most parts of the country provides opportunity for ethnobotanical surveys in such areas. Other prominent anti-snake venom plants in the Taraba state ethnobotanical survey may provide lead bioactive compounds if scientifically explored.

This work presents a considerable potential for treatment of snake envenomation, and the plants involved may provide raw material base for the local industries in the manufacture and development of marketable antiophidian drugs to combat the high incidence of snakebites in Nigeria. Although such industries already abound elsewhere, their establishment in Nigeria will provide ready markets for the sub-regional governments in sourcing plant-derived antivenom agents for the strategic management of appropriate victims. Although only few Nigerian plants have been fully characterized for bioactive antivenom compounds, the antiophidian biodiversity offers great prospects in the discovery of leads for the manufacture of antivenom drugs to complement conventional therapies.

Screening studies of venom inhibition by Nigerian plant extracts and isolated compounds which are conveniently performed using in vivo assays, should be complemented by in vitro tests for adequate evaluation of their therapeutic potential as alternative drugs against snake bites. In spite of the effectiveness of medicinal plants for snakebites treatment, clinical evaluations to further confirm efficacy in humans prior to large-scale use is recommended.

The use of plant-derived remedies as antidotes for snake venom is a common practice in instances...
where prompt access to serum therapy is lacking, and is also used as an alternative to conventional antivenom serotherapy. In general, many neutralizing actions of plant extracts, or their isolated compounds on snake venoms are more visible \textit{in vitro} models, suggesting development of new procedures that will ensure rapid contact between the plant antivenom agents and venom or isolated toxin to achieve an efficient inactivation of toxicity.

\textbf{Table I:} Profile of Nigerian plants with anti-snake venom activity

<table>
<thead>
<tr>
<th>S/No</th>
<th>Plant/ Family</th>
<th>Common name (CN)/ (local names)</th>
<th>Plant part studied</th>
<th>In vitro activity</th>
<th>In vivo activity</th>
<th>Isolated bioactive compound</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>\textit{Annona senegalensis} Pers (Annonaceae)</td>
<td>African custard apple/ Hausa (&quot;gwandar daajii&quot;) , Yoruba (&quot;abo&quot;)</td>
<td>Leaf</td>
<td>Not specified</td>
<td>1) Methanol extract (ME) and most active column fraction III (100mg/kg) neutralized lethal toxicity induced by \textit{Echis ocellatus} venom. 2) Intradermal injection of mixture (ME + 7.5mg/kg venom, 1:30, 37°C, 30min) exhibited 75% protection on mice in 24h. 3) Fraction III gave weak inhibitory effect on fibrinogen clotting activity of venom</td>
<td>1) Methanol extract (ME) and most active column fraction III (100mg/kg) neutralized lethal toxicity induced by \textit{Echis ocellatus} venom. 2) Intradermal injection of mixture (ME + 7.5mg/kg venom, 1:30, 37°C, 30min) exhibited 75% protection on mice in 24h. 3) Fraction III gave weak inhibitory effect on fibrinogen clotting activity of venom</td>
<td>cabenegrins A-I and A-II (phenolic pterocarps)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rootbark</td>
<td>Mixture of ME (50 - 200 mg/kg) and \textit{Naja nigricollis} venom reduced venom-induced hyperthermia, and detoxified snake venom by 16 - 33%</td>
<td>Not specified</td>
<td>Root aqueous extract (AQ) inhibited \textit{Bitis arietans} venom PLA2 and stimulated protease activity</td>
<td>36, 37</td>
</tr>
</tbody>
</table>
|   | **Aristolochia albida** Duch. (Aristolochiaceae) | Dutchtman’s pipe/ Hausa ("dumanduutsee") | Rhizome | Not specified | 1) ME gave 44.4% protection to *Naja nigricollis*-envenomed mice  
2) Extract gave anticoagulant, haemolytic and PLA₂ activities | Aristolochic acid, an alkaloid | 2, 38 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td><em>Asystasia gangetica</em> (L.) (Acanthaceae)</td>
<td>Creeping foxglove/ Igbo (&quot;uni-inwatura&quot;), Yoruba (&quot;lobiri&quot;)</td>
<td>Leaf</td>
<td>Not specified</td>
<td>Pre-treatment of mice with ME (1000mg/kg) prior i.p injection of <em>Naja melanoleuca</em> venom resulted in 60% protection</td>
<td>Not specified</td>
<td>39</td>
</tr>
</tbody>
</table>
| 4. | *Bryophyllum pinnatum* (Lam.) Oken (Crassulaceae) | Resurrection plant/ Yoruba ("abamoda"), Igbo ("odaopue") | Leaf | 1) ME, dichloromethane (DCM) and AQ fractions at 100 - 500 μg/mL inhibited adenosine diphosphate (ADP)-induced platelet aggregation in *Bitis arietans* model.  
2) AQ fraction was the most potent inhibitor of platelet aggregation in *Naja nigricollis* model. | Flavonoids- O-glycosides | Flavonoids- O-glycosides | 2, 28 |
| 5. | *Crinum jagus* (Thomps) Dandy (Amaryllidaceae) | Harmattan lily/ (Yoruba: "ogede-odo"), Hausa "gadalal") | Bulb | Not specified | 1) Equipotent AQ fraction and ethanol extract (EE) (50-56% protection) at 200mg/kg, plus their column fractions neutralised *Echis ocellatus*-envenomed rats in 24h. Fraction III of AQ (75% protection), and fractions II and III (75% protection) of EE gave the best result  
2) Crude AQ extract and fraction III completely neutralised haemorrhagic activity (coagulopathy) after 24 h | Resveratrol (phenolic compound) | 2, 40 |
1) ME at 1000 mg/kg given orally, protected 50% mice against *Echis ocellatus*,
2) injection of ME + venom (10 mg/kg, i.m) resulted in 100% protection.
3a) ME (500 mg/kg) gave 50% protection against *Bitis arietans* venom in mice, 3b) while i.p administration of pre-incubated ME + venom was more active against *Naja nigricollis*,
4) Similar creatine kinase level was recorded after oral treatment of mice with ME prior to injection of *Echis ocellatus* (or *Bitis arietans*).

| 6. | *Detarium microcarpum* Guill. et Perr. (Fabaceae) | Sweet detar/ Hausa ("taura"), Yoruba ("ogbogho"), Igbo ("ofo") | Leaf | Not specified | 1) ED$_{50}$ in *Echis carinatus* pretreated-mice after i.p and p.o injections with AQ extract were 50 mg/kg, and > 200 mg/kg respectively. 2) Incubation mixture (Extract + venom) gave ED$_{50}$ 50 mg/kg. 3) In ME pre-treated mice, subsequent i. p. injection was more potent (ED$_{50}$ = 100 mg/kg) than p.o injection (ED$_{50}$ 400 mg/kg). | Not specified |

| 7. | *Guiera senegalensis* J. F. Gmel. (Combretaceae) | CN: -/ Hausa ("sabara") | Leaf | AQ extract detoxified *Naja nigricollis* and *Echis carinatus* venoms. | Mice treated with incubation mixture of *Naja nigricollis* venom plus AQ extract were adequately protected | Not specified |

| 8. | *Indigofera pulchra* Wild (Fabaceae) | CN: -/ Hausa ("bakinbuunuu"), Yoruba ("ejaomode") | Aerial parts | Not specified | 1) ME protected 33.3% of *Naja nigricollis* envenomed mice, 2) neutralized anticoagulant, haemolytic and PLA$_2$. | Not specified |

<p>| 9. | <em>Luffa aegyptiaca</em> (L.) M. Roem. (Cucurbitaceae) | Sponge gourd/ Hausa (&quot;baska&quot;), Igbo (&quot;agbo&quot;), Yoruba (&quot;kaankanoyinbo&quot;) | Leaf | 1) AQ extract and EE non-competitively inhibited <em>Naja nigricollis</em> protease activity 2)EtOAc fraction from EE competitively inhibited the enzyme at 0.1 and 0.05%, | Not specified | Not specified |</p>
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Species</th>
<th>Common Names</th>
<th>Part Used</th>
<th>Preparation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td><em>Mucuna pruriens</em> (L.) DC. (Fabaceae)</td>
<td>Velvet bean/ Yoruba (“werepe”), Igbo (“agbala”)</td>
<td>Seed</td>
<td>Not specified</td>
<td>1) AQ extract (21mg/kg) inhibited <em>Echis carinatus</em>-induced increases in lactate dehydrogenase, glutamic pyruvic transaminase and creatinine kinase in rats. 2) Animals pre-treated with single and multiple doses maintained enzymic levels and showed anticoagulant activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increase in procoagulant activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Anti-bodies-rich AQ extract effectively neutralized lethality of <em>Naja</em> venom</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1) Multiform glycoprotein (a protein fraction) in seeds inhibited both trypsin and chymotrypsin activities, thermally stable maintaining its trypsin inhibitory activity up to 50°C. 2) Whole protein extract inhibited prothrombin activation by ecarin and <em>Echis carinatus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Antibodies-rich AQ extract effectively protected rats against <em>Naja nigriceps</em> and <em>Calloselasma rhodostoma</em> envenomation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ME (1000mg/kg) prior i.p injection of <em>Naja melanoleuca</em> venom to mice offered 80% protection.</td>
</tr>
<tr>
<td>12.</td>
<td><em>Newbouldia laevis</em> (P. Beauv.) Seem (Bignoniaceae)</td>
<td>Boundary tree/ Hausa (“aduruku”), Yoruba (“akoko”), Igbo (“ogirisi”)</td>
<td>Leaf</td>
<td>Not specified</td>
<td>ME (500mg/kg) prior i.p injection of <em>Naja nigricollis</em> venom to mice offered 70% protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1) Water-ME extract significantly protected chick biventercervicis muscle preparation from <em>Naja nigricollis</em> venom-induced inhibition of neutrally evoked twitches. 2) Reduction in loss of responses to acetylcholine, carbachol, KCL normally blocked by venom, 3) Protected murine muscle cells in culture against cytotoxic effects of <em>Naja nigricollis</em> and <em>Echis ocellatus</em> venom at 75 - 300µg/mL. 4) Completely blocked haemorrhagic activity of venom</td>
</tr>
<tr>
<td>13.</td>
<td><em>Parkia biglobosa</em> (Jacq.) R. Br. ex G. Don (Fabaceae)</td>
<td>African locust bean</td>
<td>Stem bark</td>
<td>Not specified</td>
<td>ME and <em>Echis ocellatus</em> venom mixture injected to mice gave 40% protection</td>
</tr>
</tbody>
</table>

* Volume 4 No 1, 2020

Nigerian Medicinal Plants, Gbolade et al,
<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Common Names</th>
<th>Part Used</th>
<th>Extraction Method</th>
<th>Effects</th>
</tr>
</thead>
</table>
| 14. | *Paullinia apinnata* L.       | *Tietic’ Yoruba “kakashenla”, Hausa (“hannubiyar”) | Root bark  | Not specified    | 1) Pre-treatment with AQ extract resulted in ED₅₀ 300mg/kg and > 400mg/kg, respectively after subsequent i.p and o.p injections with *Echis carinatus*
2) Injection of incubation mixture (extract + venom) produced ED₃₀ 100mg/kg.
3) p.o injection of extract to mice was more potent (ED₄ 400mg/kg) than i.p treatment (ED₄ > 400mg/kg).
4) Extract restored blood clotting time and bleeding time in rats, reversed venom-induced increase in capillary permeability in rabbits. |
| 15. | *Schumanniophyton magnificum* (K. Schum.) Harms. (Rubiaceae) | Skin of chimpanzee/ Igbo “akpukoozo” | Stem bark  | Peptide isolated from AQ extract inhibited effects of cardiotoxin and total venom of cobra in the chick biventercervicis preparation model | Not specified A peptide and Schumanniofoside (a chromone alkaloidal glycoside) |
| 16. | *Securidaca longipedunculata* Fres (Polygalaceae) | Violet tree/ Hausa “uwarmagungun” | Leaf, root bark | Not specified | 1) Root bark AQ extract (300 mg/kg) completely protected *Naja nigricollis*-envenomed rats, leaf AQ extract was inactive
2) combined leaf and root bark extracts gave 66.67% protection at 300 mg/kg and 33.33% protection at 200 mg/kg |
| 17. | *Sterculia setigera* Del.     | Karaya gum tree                    | Stem bark  | Not specified    | AQ extract offered 22.2% protection to *Naja nigricollis*-envenomed mice |
| 18. | *Teckona grandis* L. f       | Teak                              | Stem bark  | Not specified    | ME (50 mg/kg) offered 75% and 50% protection to *Naja nigricollis* - and *Bitis arietans*-envenomed mice, respectively |
| 19. | *Tithonia diversifolia* Hemsl. A. Gray (Asteraceae) | Mexican sunflower                  | Leaf       | ME at 100- 500 μg/mL was the most active inhibitor of ADP-induced platelet aggregation (66.7- 84.8%) in the *Bitis arietans* model. ME, DCM and AQ fractions were similarly active (68-74%) in *Naja nigricollis* model | AQ fraction of ME was a better agent in both *Bitis arietans* (complete protection at 24h) and *Naja nigricollis*-envenomed mice, and rat models. |
| 20. | *Uvaria chamae* P. Beauv.     | Finger root/ Hausa (“kaskafi”), Yoruba (“enju”), Igbo (“mmimini ohca”) | Leaf       | Not specified    | ME (400 mg/kg) prior to i.p administration of *Naja nigricollis* venom neutralized some biological effects (enzymic activities, bleeding time) of venom in rats. |
Funding
The study was sponsored by the author, for study design and conduct, collection, analysis and interpretation of data, preparation of the article, and submission of the article for publication.

Author contributions
The author AAG was the sole contributor to this manuscript.

Conflicts of interest:
None

REFERENCES


8. Gbolade AA. The medicinal and pesticidal potential of Nigerian Plants In: Proceedings of First International Symposium on Utilization of Natural Products in Developing Countries: Trends and Needs. (Ed. A Mansingh, RE Young, T Yee, R Delgoda, DE Robinson, E Morrison and H Lowe), The Natural Products Institute, The University of the West Indies, Mona, Kingston, Jamaica, 2000; p.107-16.


42. Iful ES. Studies on the antivenom activities of the aqueous extracts of *Paulinia pinnata* and *Detarium microcarpum* against *Echis carinatus* (carpet viper) venom. PhD thesis (Pharmacology), University of Jos, Nigeria, 2008; 188pp.