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Plants with Piscicidal Activities in Southwestern Nigeria

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Abstract

Field survey was carried out in the South-west Nigeria to identify and document some Nigerian piscicidal plants with known active ingredients with the view of ensuring their further development and conservation. The trial toxicity tests using ten out of the forty piscicidal plants documented produced 100% mortalities of catfish (*Clarias gariepinus*) between 4 and 12 hours exposure to 120ppm concentration. *Tetrapleura tetraptera* and *Senna occidentale* recorded 100% mortality of *C. gariepinus* at 4th hour exposure and hence more potent than *Bridella micrantha* and *Sesbania pachycarpa*, which recorded 100% fish mortality after 11th hour of exposure. Fish had a longer survivorship at the lowest concentration (40 ppm), which was at variance with the different piscicidal plants tested. Toxicity test results were significantly different ($P<0.05$) when compared with the different concentrations and control experiment.

Application of the documented botanicals on freshwater ecosystems varied and depended on the part(s) of the plant in use, its potency, mode of extraction (pounding, cutting, powdery, or whole soaking) and active ingredients. These plants are mostly used between October and January (dry season) and after the first rainfall of the year to stupefy fish before cropping.

Key Words: Piscicidal, botanical, ingredient, stupefy, potency, catfish.

Introduction

Plant poisons are extracted from flowers, bark, pulp, seed, fruit, root, leaves and even the entire plant (Lamba, 1970; Tyler, 1986). These plants poisons are not there for man's use but to protect plants from external invasion and also for productivity (Weiss, 1973). According to F.A.O. (1991), more than 60,000 plant species are used for various purposes all over the world. Approximately 1,190 pure chemical substances extracted from higher plants are used in medicine throughout the world (Farnsworth *et al*., 1985). The current estimate in the number of Nigerian species of flowering plant range between 150,000 to 200,000 species in some 300 families and 10,500 genera (Forest Herbarium, 1995).

Several publications have been made on traditional plants of Nigeria to document their medicinal importance and active ingredient(s) (Adesina, 1982; Alade and Irobi, 1993; Fasola, 2000). Plant extracts are referred to as botanicals and when poisonous to fish are called piscicides (Burkill, 1985). Such piscicidal plants contain different active ingredients known as alkaloids such as nicotine, pyrethrum, ryania, rotenone, coumerin, resin, akuammine, tannins, saponins and diosgenin (Wang and Huffman, 1991). However, these alkaloids are toxic to fish and other aquatic organisms at high concentrations and wear off within a short time (Crandall and Goodnight, 1962; Olaifa *et al.*, 1987; Kulakkattolickal, 1987; Adewunmi, 1990).

Aquatic ecosystem control by synthetic organic compounds has been reported to cause contamination of waterways and this endangers organism living therein (Dalela *et al.*, 1978). Synthetic organic compounds are identified with problems of environmental resistance, pest resurgence and detrimental effects on non-target organisms because of their non-degradability. The importance of ethno botanical studies as cost-effective means of locating new and useful plant compounds shows that commercial synthesis of drugs cost more than extractions from plants. Also, the use of botanicals has been found to aid fish cropping greatly as it saves time of fishing and increase easy handling of even stubborn fish like *Gymnarchus*, *Heterotis* and *Clarias* (Burkill, 1985).

Botanicals have broad-spectrum activities and can be extracted in commercial qualities (Olaifa *et al.*, 1987). They are biodegradable (Kela *et al*., 1989), less severer than synthetic chemicals (Ahmed and Grainge, 1986), and easily reversed in fish subjected to chronic concentrations (Onusiriuka and Ufodike, 1998). An urgent study of piscicidally important plants is needed before their habitats in the Southwest Nigerian rainforests and savanna are completely destroyed.

Materials and Methods

Field survey was carried out in South-west Nigeria in seven states (i.e Oyo,Ogun, Oshun, Lagos,

Kwara, Ondo and Ekiti). Areas surveyed were Ikorodu, Epe and Okokomaiko in Lagos; Abeokuta, Ijebu-ode, Odeda, Ilaro, Imeko and Ayetoro in Ogun; Ibadan, Lagelu, Akinyele, Iseyin, Ago-Are, Egbeda and Olokemeji in Oyo; Akure environments in Ondo; Ipoti, Ijero, and Ikere-Ekiti in Ekiti; Ede, Ikire, Apomu, Ife and Oshogbo in Oshun; Ilorin, Eyenkori and Asa in Kwara (Figure 1).

The survey spanned through June 1993 to May 1995, April 1999 to July 2000 and May2002 to August 2003 intermittently as some areas were only surveyed during festive periods. One hundred prepared questionnaire copies each for 1993/94, 1994/95, 1999/2000 and 2002/2003 were administered both orally and in written forms to the local artisanal fishermen and State/Federal Agricultural Ministries respectively to elicit type of piscicidal plants in each locality, its location, usage, part use, active ingredient, family and scientific name. The data were analysed using student *t-test*.

Samples of all plant fish poisons (piscicidal plant) found in all the different locations were collected and taken to the Department of Botany / Microbiology, University of Ibadan, Faculty of Forestry / Agricultural Science, University of Ibadan and Forestry Research Institute of Nigeria, Ibadan, for proper identification and taxonomy. Available literature and data from various sources were consulted to produce the list of some Nigerian (South-west) plants of known piscicidal effects with their active ingredients, habits and families.

Ten of these sampled poisons (i.e. *Picralima nitida, Xanthosoma mafaffa, Kigelia africana, Senna occidentale, Bridelia micrantha, Tetrapleura tetraptera, Raphia vinifera, Sesbania pachycarpa* and *Parkia biglobosa)* were randomly selected and tried on catfish (*Clarias gariepinus*) fingerlings (total length=11.2+0.4 cm) in rectangular concrete tanks (2x4x1.5m) at the laboratory. 50g of each plant poison were pounded using mortal and pestle and soaked in 10 litres of water for 2 days to ferment. This solution was applied at 0, 2, 4 and 6 litres per 20 litres tank half filled with water to make 0ppm, 40ppm, 80ppm and 120ppm concentrations. Twenty fish were added to each of the experimental tanks and a control tank in replicates and toxicity test lasted for 24 hours using Sprague (1970) method. Duncan multiple range test was used to analyse the results. Observation was made at 1, 2, 4, 8, 12, 16, 20 and 24 hours for fish mortality and behaviour.

Mode of extraction, application and time of usage of these plant poisons were observed on lotic waters like Rivers Ogun, Oshun, Ona, Ogunpa, Omi, Awon, Eekosin, Oba and Owena The lentic waters like ponds and man-made lakes which were either created for temporary or permanent use were also studied.

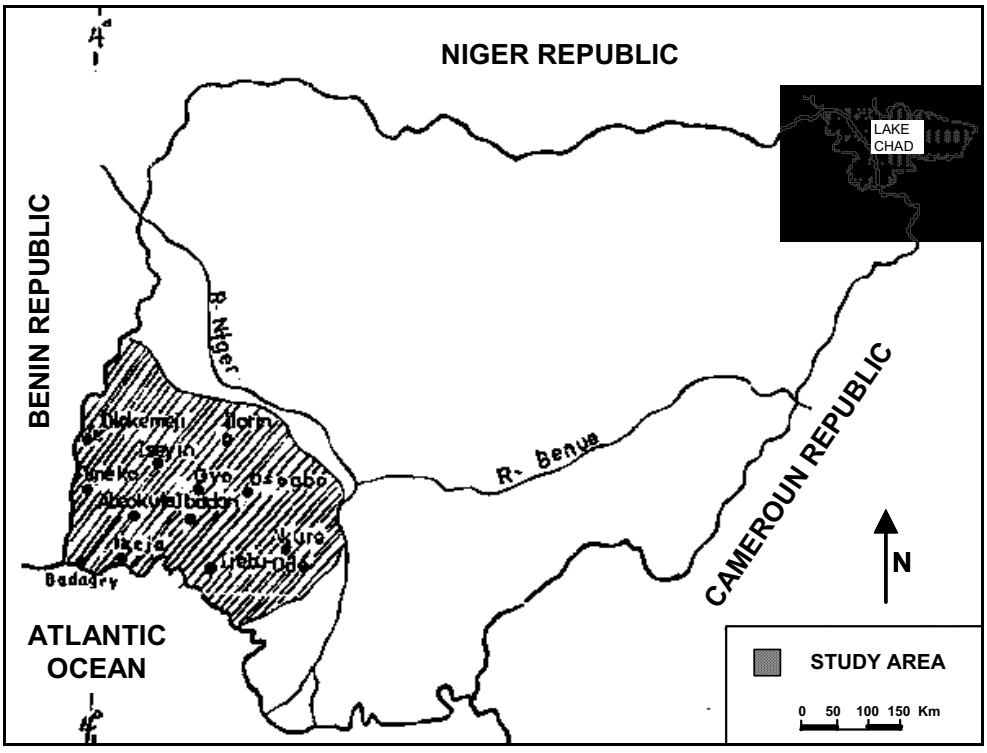

Figure 1. Map of Nigeria showing the areas surveyed (sahaded) in the southwest for distribution and use of piscida plants on aquatic environment.

Results

The list of piscicidal plants in the surveyed areas included their family names, habits, active ingredients and plant's parts used on fish (Table 1).

There were forty piscicidal plants consisting of 22 families. The families and the number of respective genera are as follows: Amaranthaceae (1), Anacardiaceae (1), Apocynaceae (4), Araceae (1), Bignoniaceae (2), Boraginaceae (1), Bursaraceae (1), Cesalpinaceae (4), Cannabinaceae (1), Caricaceae (1), cucurbitaceae (1), Euphorbiaceae (5), Leguminoceae (1), Mimosaceae (4), Palmae (1), Papiliopnaceae (4), Piperaceae (2), Passifloraceae (2), Polygaloceae (1), Rutaceae (1), Sapindaceae (1) and Solanaceae (1). The frequency of occurrence (status) shows that some plant poisons are either rare, common or abundant. Some plant piscicides are more favoured for use to crop fishes over another even though such plants are not found in that locality. Examples include *P. nitida, T. neriifolia* and *R. vinifera* in Ikire (Osun State), *A. lobata,* and *L. aegyptiaca* in Akure (Ondo State), *K. africana* and *P. biglobosa* in Ijebu (Ogun State), *P. guineense* and *T. vogelii* in Ilesha/Epe (Lagos State) and *E. suaveolens* , *S. occidentale* and *X. mafaffa* in Ibadan (Oyo State).

Result of the trial toxicity test using ten of these botanicals on catfish shows 100% mortalities between 4 and 12 hours of exposure to 120ppm concentration (Table 2). While *T. teraptera* and *S. occidentale* recorded 100% mortalities of *C. gariepinus* within 4 hours of introduction, 100% mortalities of *C. gariepinus* were only recorded after 11th hour of exposure to *B. micrantha* and *S. pachycarpa.* At the lowest concentration (40ppm) of the botanicals, fish had a longer survivorship, which was at variance with the different piscicidal plants used. One hundred percent mortality could not be recorded in *S. pacchycarpa* at 24-hour exposure. However all the results were significantly different when compared with the different concentrations and control at 5% probability level. Some erratic behaviours were recorded prior to fish mortality. Such behaviours include, zig-zag movement, jumping out of water, occasional jerking of tail, sprawling and rolling movement.

Mode of extraction, application and time of usage of the listed plant piscicides are given in Table 3. Application of these botanicals on lentic and lotic waters varies and depend on the part(s) of the plants used, its potency and the mode of extraction (pounding, cutting, distil or whole soaking).

On large lotic water, the botanicals are applied to the upper course in heavy dose to stupefy fish and cropping is done downstream. In streams and small rivers, damming before application of botanicals is carried out. Botanicals are then broadcast in heavy dose 24 hours prior to cropping. In lentic water, botanicals are either broadcast on the surface of water or packed in big nylon sacks and centrally soaked in water for between 3 and 5 days to stupefy fish before cropping.

These piscicidal plants are used on freshwater aquatic ecosystem between October and January (dry season) and after the first rainfall of the year. This period of harvesting coincides with yearly festivity of which fishing festival dominates in Igbo-Ora, Omuaran, Owena, Asejire, Ilorin, Olokemeji and Yewa environs.

Discussion

The results obtained from this study indicate a great biodiversity of piscicidally useful plants of known active ingredients in the South- west Nigerian flora. The survey also reveals that the use of piscicidal plants in Southwestern Nigeria is on the increase. This may imply that people have disengaged from the use of outlawed synthetic agrochemicals on aquatic environment to crop fish in the wild as advocated by W.H.O. (1957).

Most of the plants, being also trees, were observed in Forest Reserves (e.g. Idanre, Olokemeji, igbo-Ora and Old Oyo forests) (rare), which are now threatened with destruction in this part of the country. The urgent need to identify and preserve those useful plants that are not within protected areas have been stressed by Soladoye *et al*. (1993).

The effect of those plants tested on catfish showed that the potency of each plant varies, which was why different percentage mortalities were recorded at different exposure time and at different concentrations. The outcome toxicity tests proved that all the plants are poisonous to fish. Fish erratic behaviour prior to death is a phenomenon associated to impact of toxicants on fish.

The favour of some botanicals over the use of others to crop fish as reported under the results may be inferred on the basis of active ingredients contains (Table 1). Fafioye and Adebisi (2001) documented *R. vinifera* pods to be more toxic than *P. biglobasa* bark on Nile Tilapia (*Oreochromis niloticus*). Similarly, Onusiriuka and Ufodike (1998) reported that *Blighia sapida* bark extract is more toxic to *C. gariepinus* than *Kigelia africana* bark extract. The varied toxicities may be due to different active ingredients and usage of each botanical as indicated by Wang and Huffman (1991) and Alade and Irobi (1993).

Mode of application of these botanicals on different water bodies may be attributed to the potency of each botanical for an effective stupefying of fish. Burkill (1985) reported soaking of some plants piscicides (e.g. *Balanites aegyptiaca*, *T. vogelii* and *K. africana*) in rivers at the upper segment for 4 days before cropping fish downstream thereafter. Soaking of botanicals in water allows fermentation thereby increasing their potency on target organisms (Fafioye *et al.*, 2004). However, this action only occurs in short duration, as botanicals tend to degrade over long exposure. The extracts from these plants are

Table 1. List of some Nigerian plants with their known active ingredients and piscicidal usage.

S/ No	Plant Name	Family	Habit	Locality	Part use	Status	Active Ingredient
1	*Achyranthes aspera* Linn	Amaranthaceae	Herb	Omuaran, Bacita, Ilorin	Entire plan	C	Saponins
2	*Anacardium Occidentale* Linn	Anacardiaceae	Tree	Igbo-Ora, Iseyin, Ijebu	Bark	A	Cardol Anacardic acid
3	*Picralima nitida* Staof, Th. H. Dur	Apocynaceae	Tree	Forestry Hill, Ibadan.	Unripe fruits	C	Akuammidine
4	*Rauvolfia vomitoria* Afzel	Apocynaceae	Tree	Gambari, Idanre	Stem	R	Reserpine Rescimamine
5	*Strophanthus sarmentosus* DC	Apocynaceae	Climber	Akure, Olokemeji, Old Oyo	Whole plant	C	Sarmutogenin
6	*Thevetia neriifolia* (L) Juss ex	Apocynaceae	Tree	Olokemeji, Igbo Ora	Stem	R	Theventine
7	*Xanthosoma mafaffa* Schott	Araceae	Herb	Abeokuta, Akure, Ijebu, Lagos	Root	C	Rotenone
8	*Kigelia africana* (Linn.) Benth.	Bignoniaceae	Herb	Akure, Abeokuta, Olokemeji	Bark	R	Coumarine
9	*Indigofera hirsuta* Linn.	Bignoniaceae	Herb	Ibadan, Yewa, Ilorin	Bark	R	Saponin
10	*Synphytum tuberosum* Linn	Boraginaceae	Herb	Olokemeji	Bark	R	Allantoin
11	*Pachylobus edulis* G. Don	Buiseraceae	Tree	Ondo, Owode, Otta,	Bark	C	Resin
12	*Senna alecandrina* Mill	Caesalpinocideae	Tree	Asejire, Igboora, Ile-Ife, Ikire	Bark	C	Aloe-emodin
13	*Senna occidentale* (Linn.)	Ceasalpinoideae	Woody herb	Ilorin, Owena, Gambari,	Bark	C	Saponins
14	*Erythrophleum suaveolens* (Guill.&Perr.) Brenan	Ceasalpinoideae	Tree	Oyo, Osogbo	Bark	R	Saponins
15	*Carica papaya* Linn.	Caricaceae	Tree	Akure, Ibadan, Osogbo	Leaves	A	Piparine
16	*Luffa aegyptiaca* Mill.	Cucurbitaceae	Herb	Yewa, Ijebu, Akure,Oyo	Unripe fruits	C	Resorcinol
17	*Alchronea cordifolia* (Schum & Thonn) Mill. Arg	Euphorbiaceae	Tree	Asejire, Ikire, Omuaran	Root	C	Tannin
18	*Bridelia micrantha* (Hechst Baili)	Euphorbiaceae	Tree	Olokemeji, Igbo-Ora, Iseyin	Root	C	Saponins
19	*Jatropha curcas* Linn.	Euphorbiaceae	Shrub	Ilaro, Ibadan, Eruwa, Ekiti	Root	C	Curcin
20	*Ricinus communis* Linn.	Euphorbiaceae	Herb	Kabba,Ilorin,Okenne, Shaki, Ejigbo, Iwo	Entire plant	R	Ricin Glyceryl
21	*Manihot esculenta* Crantz	Euphorbiaceae	Shrub	Oshogbo, Ibadan, Akure	Root	A	Cyanide
22	*Acacia sieberana* DC	Leguminoseae	Tree	Yewa, Akure, Oyo	Pods	R	Alkaloids
23	*Parkia biglobosa* (Jacq.) R.Br. exc Don.	Mimosoideae	Tree	Ilorin,Abeokuta, Akure, Ijebu	Pods	A	Parkine
24	*Entada abyssinica* Stena ex A.Rich	Mimosoideae	Tree	Eruwa, Igbo Ora,	Pods	R	Saponins
25	*Pentaclethra macrophylla* Benth.	Mimosoideae	Tree	Ilaro, Owo, Mamu	Pods	R	Tannin
26	*Tetrapleura tetraptera* (Schum & Thonn) Taub	Mimosoideae	Tree	Olokemeji, Gambari,	Pods	R	Oleanolic acid Glyoside
27	*Areca catechu* Linn.	Palmae	Tree	Akure, Ekiti, Ilorin	Pods	C	Arecoline, Tannin
28	*Raphia vinifera* P.Beauv.	Palmae	Tree	Lagos, Ijebu, Ibadan	Fruits/pods	C	Tannin
29	*Tephrosia vogelii* Hook	Papilionoideae	Herb	Abeokuta environs.	Entire plant	R	Akuammidine
30	*Bobgunnia madagascanensis* (Desv.) J.H. Kirk brr& Wiersema	Papilionoideae	Tree	Igbo-Ora, Yewa	Pods	R	Resin
31	*Milletia grifoniana* Baill.	Papilionoideae	Tree	Akure, Ondo, Asejire	Bark	C	Rotenone
32	*Sesbania pachycarpa* DC	Papilionoideae	Tree	Ibadan environs	Fruits	R	Resin
33	*Adenia cissampeloides* (Planch.) Harms.	Passifloraceae	Tree	Yewa environs	Seed	R	Alkaloids
34	*Adenia lobata* (Jacq.) Engl.	Passifloraceae	Tree	Abeokuta, Imeko	Leaves	R	Alkaloids
35	*Piper guineense* Schum and Thonn.	Piperaceae	Climber	Olokemeji, Ibadan,Owo	Seed	C	Amide alkaloids Piperine
36	*Piper nigrum* Linn.	Piperaceae	Herb	Asejire, Ijebu, Olokemeji	Seed	C	Piperine
37	*Securidaca longepedunculata* Fres.	Polygaloceae	Tree	Olokemeji, Ogbomosho, Ago-Are	Bark	R	Glycoside
38	*Clausena anisata* (Wild) Benth.	Rutaceae	Tree	Okeho, Ijaiye, Imeko, Olokemeji, Ejigbo	Bark	R	Coumarin Carbazole Alkaloids
39	*Paullinia pinnata* Linn.	Sapindaceae	Herb	Ibadan, Ijebu, Oshogbo	Roots/seeds	C	Saponin
40	*Nicotiana tabacum* Linn.	Solanaceae	Herb	Ago-Are, Igbetti, Iseyin, Ilugun, Igboho	Leaves/unripe fruits	C	Nicotine

Key: R-rare (less than 5 trees per $100m^2$) ; C-common (between 5-15 trees per $100m^2$) ; A-abundant (above 15 trees per $100m^2$)

Table 2. Percentage mean mortality recorded for trial toxicity test of ten randomly selected piscicidal plants exposed to *Clarias gariepinus* for 24 hour duration

Piscicidal Plant	Tanks	Percentage Mortality/Time (hour)								
		0	1	2	4	8	12	16	20	24
Achyrathes aspera	1	0	20^{c}	35^{d}	60^{c}	85^{b}	100^{a}	-	-	-
	2	0	25^{c}	50^{c}	90^{a}	100^{a}	-	-	-	-
	3	0	40^{a}	80^{a}	100^{a}	-	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Bridelia micrantha	1	0	5^{e}	20^{e}	35^{d}	40^{d}	50d	65^{c}	80^{b}	100^{a}
	2	0	10^{d}	30^{d}	50c	60^{c}	75^{b}	90^{a}	100^{a}	-
	3	0	10^{d}	50^{c}	70^{b}	85^{a}	100^{a}	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Kigelia africana	1	0	20^{c}	35^{d}	50^{c}	70^{c}	95^{a}	100a	-	-
	2	0	30^{b}	55^{b}	85^{b}	100^{a}	-	-	-	-
	3	0	35^{b}	70^{a}	100^{a}	-	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Parkia biglobosa	1	0	10^{d}	20^{e}	35^{d}	50^{d}	70^{b}	90^{a}	100^{a}	-
	2	0	20^{c}	35^{d}	55^{c}	75^{b}	90^{a}	100^{a}	-	-
	3	0	25^{c}	50^{c}	80^{b}	100^{a}	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Picralima nitida	1	0	10^{d}	20^{e}	40^{d}	55^{d}	80^{b}	100^{a}	-	-
	2	0	20^{c}	35^{d}	55^{c}	80^{b}	100^{a}	-	-	-
	3	0	30^{c}	50^{c}	85^{b}	100^{a}	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Raphia vinifera	1	0	10^{d}	15^{f}	25^{e}	40^{d}	65^{c}	80^{b}	100^{a}	-
	2	0	20^{c}	30^{d}	45^{d}	60^{c}	75^{b}	100^{a}	-	-
	3	0	35^{b}	65^{b}	85^{b}	100^{a}	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Senna occidentale	1	0	10^{d}	25^{e}	40^{d}	60^{c}	75^{b}	90^{a}	100^{a}	-
	2	0	20^{c}	35^{d}	60^{c}	80^{b}	100^{a}	-	-	-
	3	0	25^{c}	60^{b}	100^{a}	-	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Sesbania pachycarpa	1	0	5^{e}	15^{f}	25^{e}	30^{e}	35^{e}	50^{d}	70^{c}	90^{a}
	2	0	10^{d}	20^{e}	30^{d}	45^{d}	60^{c}	75^{b}	90^{b}	100^{a}
	3	0	15^{d}	40^{c}	65^{c}	90^{b}	90^{a}	100^{a}	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Tetrapleura tetraptera	1	0	15^{d}	35^{d}	50^{c}	70^{c}	85^{b}	100^{a}	-	-
	2	0	20^{c}	45^{c}	70^{b}	85^{a}	100^{a}	-	-	-
	3	0	40^{a}	70^{a}	100^{a}	-	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}
Xanthosoma mafaffa	1	0	10^{d}	25^{e}	40^{d}	55^{d}	80^{b}	95^{a}	100^{a}	-
	2	0	20^{c}	35^{d}	50^{c}	75^{b}	90^{a}	100^{a}	-	-
	3	0	30^{b}	60^{b}	80^{b}	100^{a}	-	-	-	-
	4	0	0^{f}	0^{g}	0^{f}	0^{f}	0^{f}	0^{e}	0^{d}	0^{b}

Key: Tank 1=40ppm; tank 2=80ppm; tank 3=120ppm; tank 4=0ppm (control). 0=no mortality; - = not applicable
Means with the same superscript letter along vertical column are not signficantly different (P>0.05).

Table 3. Mode of Extraction, Application and Time of usage of the documented piscicidal plants in South-western Nigeria

S/No	Plant Name	Mode of Extraction	Application Lentic	Application Lotic	Time of Usage on Water
1	*Achyranthes aspera* Linn	Fresh herb pounded and soak in water	Soak centrally.	Broadcast Upstream	October-November
2	*Anacardium Occidentale* Linn	Bark soak in water	Soak	Broadcast	October-December
3	*Picralima nitida* (Staof, Th. H. Dur	Seeds may be dried and grinded into powdery form/fresh seeds soak in water	Soak/Broadcast	Broadcast	October/November
4	*Rauvolfia vomitoria* Afzel	Stem cuttings soak in water	Soak	Soak	November-January
5	*Strophanthus sarmentosus* DC	Fresh plant pounded and soak in water	Broadcast	Broadcast	October/November
6	*Thevetia neriifolia* (L) Juss ex	Stem cuttings soak in water	Soak	Broadcast	November-January
7	*Xanthosoma mafaffa* Schott	Root cuttings soak in water	Soak	Broadcast	October
8	*Kigelia africana* (Linn.) Benth.	Barks are pounded before soak in water	Soak centrally	Broadcast	October-December
9	*Indigofera hirsuta* Linn.	Whole plant is soak in water	Soak centrally	Soak upstream	October/November
10	*Synphytum tuberosum* Linn	Bark grinded and soak in water	Broadcast	Broadcast	October
11	*Pachylobus edulis* G. Don	Fresh bark soak in water	Soak	Broadcast	November-January
12	*Senna alecandrina* Mill	Bark cutting soak in water	Broadcast	Broadcast	October-December
13	*Senna occidentale* (Linn.)	Fresh bark pounded and soak in water.	Soak centrally	Broadcast	October/November
14	*Erythrophleum suaveolens* (Guill.&Perr.) Brenan	Bark cuttings soak in water	Soak	Broadcast	October-January
15	*Carica papaya* Linn.	Fresh leaves pounded and soak in water	Soak	Broadcast	October-March
16	*Luffa aegyptiaca* Mill.	Pods are fermented before apply to water	Soak centrally	Broadcast	October/November
17	*Alchronea cordifolia* (Schum&Thonn) Mill.Arg.	Roots pounded and soak in water.	Soak centrally	Soak upstream	October-December
18	*Bridelia micrantha* (Hechst Baili)	Root cuttings soak in water.	Soak centrally	Broadcast	October/November
19	*Jatropha curcas* Linn.	Fresh root pounded and soak in water	Soak centrally	Broadcast	October-December
20	*Ricinus communis* Linn.	Entire plant soak in water	Broadcast	Broadcast	October/November
21	*Manihot esculenta* Crantz	Root cuttings soak in water	Soak	Broadcast	October-January
22	*Acacia sieberana* DC	Pods are fermented before apply to water	Soak centrally	Broadcast	November-February
23	*Parkia biglobosa* (Jacq.) R.Br. exc Don.	Pods are pounded and fermented before apply to water	Soak centrally	Broadcast	October-March
24	*Entada abyssinica* Stena ex A.Rich	Pods fermentation before apply to water	Soak centrally	Broadcast	October-December
25	*Pentaclethra macrophylla* Benth.	Pods fermentation before apply to water	Soak centrally	Broadcast	November-January
26	*Tetrapleura tetraptera* (Schum & Thonn) Taub	Fresh pods soak in water	Broadcast	Broadcast	October-January
27	*Areca catechu* Linn.	Pods are pounded before apply to water.	Soak centrally	Broadcast	October-January
28	*Raphia vinifera* P.Beauv.	Fruits/pods are soak raw in water.	Broadcast	Broadcast	October-March
29	*Tephrosia vogelii* Hook	Whole plants pounded and soak in water.	Soak centrally	Soak upstream	October-December
30	*Bobgunnia madagascanensis* (Desv.)J.H. Kirk brr& Wiersema	Pods are grinded before apply to water.	Broadcast	Broadcast	November-March
31	*Milletia grifoniana* Baill.	Bark cuttings soak in water	Soak	Broadcast	October-January
32	*Sesbania pachycarpa* DC	Fruits soak in water	Soak	Soak upstream	October-March
33	*Adenia cissampeloides* (Planch.) Harms.	Seeds are grinded before soak in water	Broadcast	Broadcast	October-December
34	*Adenia lobata* (Jacq.) Engl.	Fresh leaves are pounded and soak in water.	Soak centrally	Broadcast	October-December
35	*Piper guineense* Schum and Thonn.	Seeds grinded and soak in water.	Broadcast	Broadcast	October-January
36	*Piper nigrum* Linn.	Seeds pounded and soak in water.	Soak centrally	Soak upstream	October-January
37	*Securidaca longepedunculata* Fres.	Fresh bark cuttings soak in water.	Soak	Broadcast	October-December
38	*Clausena anisata* (Wild) Benth.	Barks are pounded before apply to water.	Broadcast	Broadcast	October-December
39	*Paullinia pinnata* Linn.	Roots and seeds are pounded and soak in water.	Soak centrally	Soak upstream	October-January
40	*Nicotiana tabacum* Linn.	Fresh leaves/unripe fruits are pounded and soak in water	Soak centrally	Broadcast	October-March

used in dry season when water level is low. This allows use of small quantity of botanical to stupefy fish with little effort for cropping. Also most fish species are known to mature at this period.

In conclusion, the listed plants in this study contain active ingredients, which cause physiological impairment in fish (i.e. *Clarias gariepinus*) and possibly other aquatic organisms. Most of these plants have medicinal values as well, so storage and further development of their germplasm should be ensured. It could also be suggested that more efforts should be put into developments of drugs and medicine from these plants, using modern techniques available in pharmaceutical industry.

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