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Zootechnical, Pharmacological Uses and Chemical Composition of *Napoleonaea vogelii* Hook & Planch (Lecythidaceae) in West Africa —A Review

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Abstract

Napoleonaea vogelii, Lecythidaceae family is a tropical evergreen shrub widely distributed in the coastal regions of West African countries including Benin. It is a medicinal plant whose leaves and bark are of great utility in traditional medicine. Despite its importance, it is little used in ethnoveterinary medicine and its pharmacological basis in this field and especially in the treatment of parasitic diseases caused by *Haemonchus contortus* is very little documented. This review aims to synthesise existing data on the chemical composition, pharmacological and zootechnical usefulness of *N. vogelii* and to identify the gaps of these works in order to propose research perspectives. Google Scholar database was used to gather the majority of useful information available on *N. vogelii*. The results showed that of the 23 publications included in the present study, 60.87% dealt distinctly with the pharmacological properties of *N. vogelii*. These properties include anthelmintic, antidiabetic, wound healing, antimicrobial, antibacterial, anti-inflammatory, antioxidant properties and *N. vogelii* contains many secondary metabolites including alkaloids, tannins, flavonoids, saponins, glycosides which give it its pharmacological properties. The Correspondence Factor Analysis performed for the variables extracts and chemical compounds showed that the presence of a given chemical compound is not dependent on the type of extract. This work has gathered information on *N. vogelii* and found that the species has powerful

therapeutic potentials but very little use in traditional veterinary medicine. More research is needed on this plant to make available ethnoveterinary pharmacological data to enable proper use in the treatment of animal diseases in general and gastrointestinal parasitosis of small ruminants in particular.

Keywords

Ethnoveterinary, *Napoleonaea vogelii*, Chemical Composition, Pharmacological Properties, Zootechnical Utility

1. Introduction

Plants contain several active ingredients with therapeutic properties [1]. Their use in the treatment of human and animal diseases has an important place in the life of people in Africa. Medicinal plants have been used for therapeutic purposes for many centuries [2] and this has continued into the modern era, when herbal products became more popular [3]. Also, it has been noted by researchers that people from different regions and social groups use the same or similar plants to meet primary health care needs [2] [4]. The interest in medicinal plants nowadays can be justified by their effectiveness, availability, easy access to herbal health care as well as their relatively low cost [5]. The African flora, mainly that of Benin, is endowed with several species of medicinal plants which the population uses to treat both human and animal diseases [6]. *Napoleonaea vogelii* is one such plant species. It belongs to the Lecythidaceae family and is a tropical flowering plant widely distributed in the coastal regions of West Africa mostly in the rain forest and along the sea shores, extending from Sierra-Leone through Nigeria to Benin [6] [7] [8]. The plant (shrub or a small spreading tree) grows up to 15 m high with fibrous and alternate leaves. The latter, usually 7.5 to 15 cm long and 3.25 to 7.5 cm wide are broadly elliptic, abruptly acuminate and shallowly toothed. The fruits are reddish-orange (ripe fruits) or green (unripe fruits). It is used in making wooden poles, wraps, chewing sticks and mats or to flavour rice [7]. Its fruits are edible [9] and all its organs are used for therapeutic purposes [10] [11] but there is few information on its pharmacological properties. This literature review aims to bring together in a single document the available information on the chemical composition, pharmacological and zootechnical uses of *N. vogelii* in order to shed light on this little known medicinal species in the scientific world.

2. Methods

2.1. Study Protocol

In order to meet the objective of this study, publications dealing with the outcomes of interest to the study, inclusion and exclusion criteria, source of data, criteria for preliminary evaluation of articles and criteria for evaluation of eligi-

ble articles were established in order to identify and make available to the scientific community information on the pharmacological properties of *N. vogelii* and its zootechnical importance in livestock system.

2.2. Literature Search Strategy

The literature search was conducted using Google scholar as the electronic database. This single database was chosen after an analysis of the information about *N. vogelii* available in other databases. The result showed that almost the same publications are found on PubMed, SCORPUS and Google scholar. The literature search was conducted from February 2020 to March 2021 using keywords or expressions (Table 1) as exhaustively as possible in order to gather as much information as possible about the species and its pharmacological properties. The strategy adopted is that used by Li and Zhou [12]. The French correspondents of each of the keywords in Table 1 were used. From this strategy, a total of 64 documents were found on the search topic and 23 retained after filtering and deleting those that were not of interest. The pharmacological properties stated for the plant and demonstrated by laboratory tests were identified and recorded and no language limits were applied, both English and French data available on the search term were exploited. The information was inserted into Excel spreadsheet (2016), for data encoding and processing using Graph Pad Prism 8.4.3. software for graphs and histograms and R software version 3.6.3 for Correspondence Factorial Analysis (CFA) to determine the relationship between the extracts and the chemical compounds obtained. The variables were related to the pharmacological properties of the plant, the type of test (*in vitro* or *in vivo*) and extract used, the field of application of the research (ethnoveterinary or ethnomedicine), the part of the plant used, the country where the research was conducted. In the case of *in vivo* tests, the animal model used is specified. For the CFA analysis, only the variables extracts and chemical compounds were considered.

Table 1. Search strategy and terms used to identify data on chemical composition, pharmacological and zootechnical uses of *Napoleonaea vogelii* [12].

Research terms	*Napoleonaea vogelii* or *Napoleona vogelii*, 2. properties, 3. activities, 4. effect, 5. distribution, 6. ecology, 7. use, 8. pharmacology, 9. compound, 10. chemistry, 11. animal application, 12. medicinal use, 13. traditional use, 14. local name, 15. synonym, 16. ethnoveterinary, 17. zootechnical usefulness, 18. pharmacological utility, 19. importance in traditional medicine, 20. chemical compounds, 21. bioactives compounds, 22. chemical composition, 23. secondary metabolites, 24. phytotherapy efficacy, 25. gastroenteritis properties, 26. antibacterial properties, 27. antispasmolytic properties, 28. antihelmintic properties, 29. antimicrobial properties, 30. antioxidant properties, 31. antidiabetic properties, 32. antiparasitic activities, 33. antidiarrhoeal properties.
Strategy used	1 **AND** (2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33).

2.3. Inclusion and Exclusion Criteria

In a preliminary assessment, the title and abstract of the study report were screened to ensure that they were consistent with the research theme. The papers that passed the preliminary review were carefully assessed for quality and relevance. Among the quality criteria defined up stream, the laboratory procedures were essential (*in vitro* and/or *in vivo* activities), as they guarantee the accuracy of the result obtained. Original research papers from 1964 to 2021 were included in this study. Similarly, some references within the publications used were used as a guide to search for other articles. Abstracts dealing solely with empirical knowledge of the plant without laboratory testing to confirm or refute suspected pharmacological properties were excluded from this study. The selection of the relevant articles to the study has been described in Figure 1. Similarly, dead links and thesis papers have been excluded in this review.

3. Results

3.1. Literature Search

The literature search was conducted over a period of one year and 23 published articles were retained in the present study after careful screening of a total of 64 publications, conferences and reports. Of the 23 publications selected, only 14 dealt distinctly with the pharmacological properties of *N. vogelii*, *i.e.* a total of 60.87% of the publications of interest selected. In the synthesis of the data, sixteen (16) pharmacological properties of *N. vogelii* species were identified in the West African region considering single publications that deal with several pharmacological properties at the same time such as the case of Akah *et al.* [10] who in a single publication found four (04) different pharmacological properties namely antibacterial properties, antispasmolytic properties, antidiarrhoeal properties and anti-ulcer properties (Table 3).

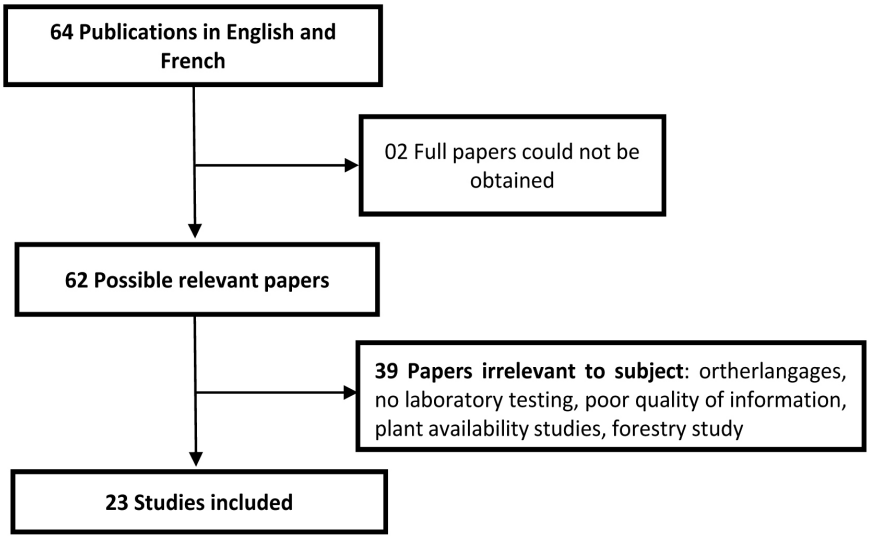


Figure 1. Flowchart of literature search.

3.2. Overview of *Napoleonaea vogelii*

Napoleonaea vogelii is a shrub or small tree belonging to the family Lecythidaceae. The genus *Napoleonaea* is a woody plant described in 1804 and comprising about ten (10) species, namely: *Napoleonaea egertonii* Baker F., *Napoleonaea gabonensis* Liben, *Napoleonaea gossweileri* Baker F., *Napoleonaea heudelotii* A. Juss, *Napoleonaea imperialis* P. Beauv, *Napoleonaea lutea* Baker F. ex Hutch & Dalziel, *Napoleonaea reptans* Baker F. ex Hutch & Dalziel, *Napoleonaea septentrionalis* Liben, *Napoleonaea talbotii* Baker F. and *Napoleonaea vogelii* Hook & Planch [13] [14]. The species *N. vogelii* has various vernacular names depending on the country of origin and also ethnic group. For example, in English language it is called "African nut tree" [15] and it is known as "Zedou" in Fon (Benin) [6]. Other names are given in **Table 2**. Sometimes used as a plant brush [16], *N. vogelii* also has other therapeutic uses: it is used in traditional medicine to treat various ailments in some West African countries [17]. The bark, leaves and root are the most commonly used parts of this plant.

3.3. Pharmacological Properties and Zootechnical Utility of *Napoleonaea vogelii* Extracts

A number of pharmacological studies were conducted on the organs of *N. vogelii* (**Table 3**). The literature showed that the leaves are widely used (71.43%) against 28.57% for the stem bark (**Figure 2**) out of 16 pharmacological properties found. In view of the data considered in the present review, it can be seen that the plant is used more for its anthelmintic properties. These have been evaluated in Ivory Coast using ethanolic extracts *in vitro* and *in vivo* on nematodes and trematodes, parasites of small ruminants and humans. According to Dro *et al.* [24], the ethanolic extract of *N. vogelii* contributed to the improvement of the

Table 2. Some names of *N. vogelii* in West Africa.

Country	Local name	Ethnicity	References
Nigeria	Gbogbori, Ito	Yoruba	[18] [19]
	Boribori	Ijebu	
	Nkpodanwaoba, Udarutobo, Nkpodo; Odure, Akpuruke, or Mkpodu; Wallia	Igbo	[8] [20] [21]
Ivory Coast	Djidji or Gaigai	Abe	[18]
	Tèkpi	Akye	
Democratic Republic of Congo	Elenkete	Nkundo	[22]
Sierra Leone	Gohema, Golohema	Mende	[18]
	Ngoroga	Loko	
Liberia	Wedi-kwa-dro, Wedi-quah-dro, Wedi-wa-doon	Kru-Basa	[18]
Ghana	Obua	Twi	[23]

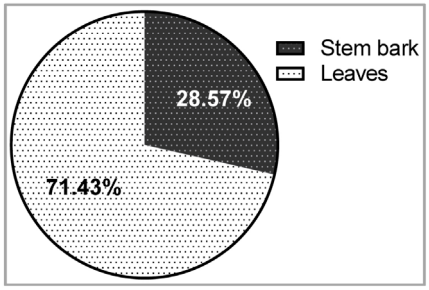


Figure 2. *Napoleonaea vogelii* organs used.

Table 3. Pharmacological properties of *Napoleonaea vogelii*, type of study conducted, plant part and extracts used.

Pharmacological properties	Experimental model	Type of activity	Type of extract	Country	Part of plant used	References	Field of study
Antihelmintic properties	-	*In vitro*	Ethanolic extract	Ivory Coast	Leaves	[25]	Ethnoveterinary
	Sheep	*In vivo*	Ethanolic extract	Ivory Coast	*Leaves*	[24]	Ethnoveterinary
	-	*In vitro*	Ethanolic extract	Ivory Coast	Leaves	[26]	Ethnomedicine
Antimicrobial properties	-	*In vitro*	Methanol and petroleum ether extracts	Ghana	Leaves and stem bark	[23]	Ethnomedicine
	-	*In vitro*	Ethanol, chloroform and butanol extracts	Nigeria	Leaves	[27]	Ethnomedicine
Antibacterial properties	-	*In vitro*	Methanol and n-hexane extracts	Nigeria	Leaves	[10]	Ethnomedicine
Antispasmolytic properties	Rabbit	*In vivo*	Methanol and n-hexane extracts	Nigeria	Leaves	[10]	Ethnomedicine
Anti-asthmatic and antitussive properties	Guinea pigs and mice	*In vivo*	Methanol extract	Nigeria	Leaves	[21]	Ethnomedicine
Antiprotozoal properties	-	*In vitro*	Aqueous extract	Democratic Republic of Congo	Stem bark	[22]	Ethnomedicine
Antidiarrhoeal properties	Mice	*In vivo*	Methanol and n-hexane extracts	Nigeria	Leaves	[10]	Ethnomedicine
Anti-ulcer properties	Rats	*In vivo*	Methanol and n-hexane extracts	Nigeria	Leaves	[10]	Ethnomedicine
Antigenotoxic properties	Rats	*In vivo*	Methanol extract	Nigeria	Stem bark	[28]	Ethnomedicine
Antioxidant properties	Rats	*In vivo*	Methanol extract	Nigeria	Stem bark	[28]	Ethnomedicine
	-	*In vitro*	Methanol extract	Nigeria	Leaves	[29]	Ethnomedicine
Hypolipidemic	Rats	*In vivo*	Methanol extract	Nigeria	Leaves	[20]	Ethnomedicine
Antidiabetic	Rats	*In vivo*	Methanol extract	Nigeria	Leaves	[20]	Ethnomedicine
Wound Healing properties	Rats	*In vivo*	Methanol extract	Nigeria	Leaves	[17]	Ethnomedicine
	Rats	*In vivo*	Methanol extract	Nigeria	Leaves	[8]	Ethnomedicine
Anti-nociceptive properties	Mice	*In vivo*	Methanol extract	Nigeria	Stem bark	[30]	Ethnomedicine
Anti-inflammatory properties	Rats	*In vivo*	Methanol extract	Nigeria	Stem bark	[30]	Ethnomedicine

zootechnical performance of sheep through a weight gain of 5.8% and a reduction of gastric emptying with a diarrhoea index = 67.3% in the lambs tested. In addition to the anthelmintic properties, the plant is also known for its antimicrobial, healing and antioxidant properties (**Figure 3**) with a wide distribution of these studies in Nigeria (**Figure 4**). This wide distribution could be explained by the fact that Nigeria is one of the coastal countries in West Africa where the plant is widely distributed and local populations have incorporated it into their traditional health care practices. More than 60% of the studies listed in this review are *in vivo* studies (**Figure 5**) using mostly rats as animal models. This is the rodent model generally used in ethnomedicine to evaluate the pharmacological properties or toxicity of a plant species. This justifies the high rate of ethnomedicinal data found in this review (**Figure 6**). *N. vogelii* contains several secondary metabolites in the leaves and/or stem bark that are responsible for its pharmacological properties [8] [9]. These secondary metabolites sometimes vary according to the type of extract used. In this literature review, seven types of solvents are used to extract the chemical compounds and evaluate the pharmacological properties of the plant. Methanolic extract is widely used, followed by ethanolic and n-hexane extracts, aqueous decoction is less used (**Figure 7**).

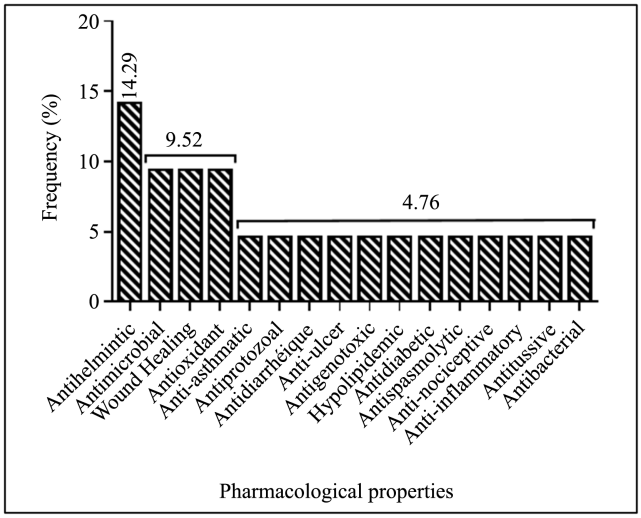


Figure 3. Pharmacological properties of *Napoleonaea vogelii*.

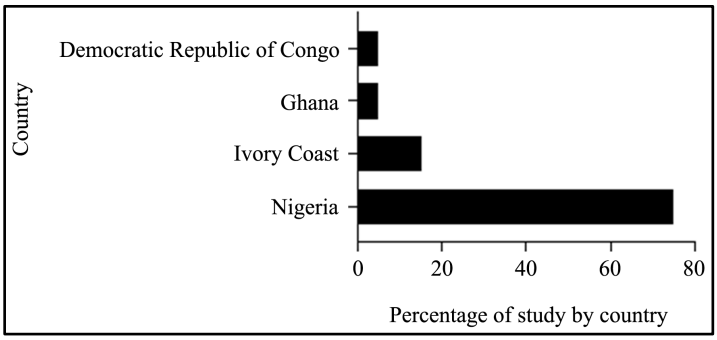


Figure 4. Distribution of studies by country.

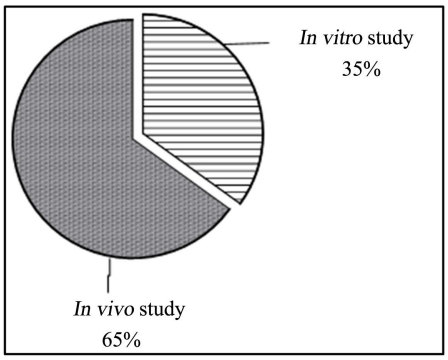


Figure 5. Type of study conducted on the organs of *N. vogelii*.

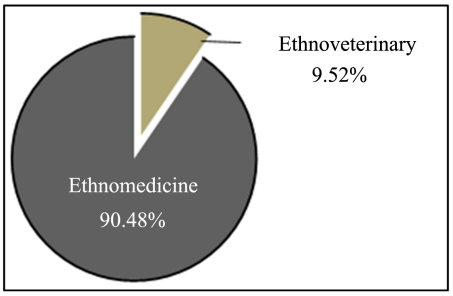


Figure 6. Study area.

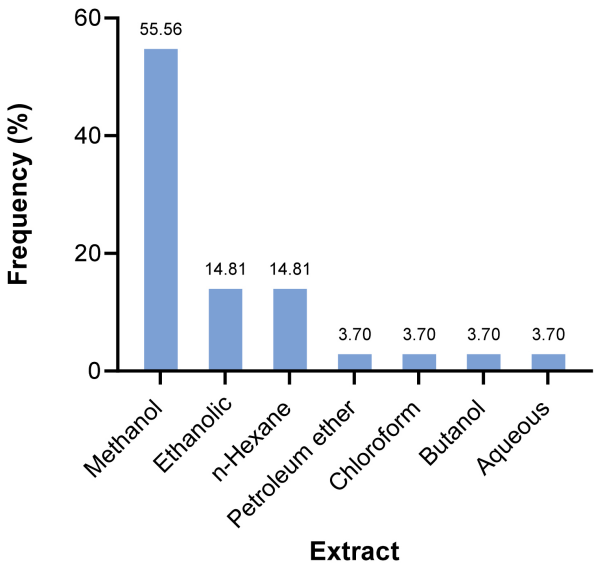


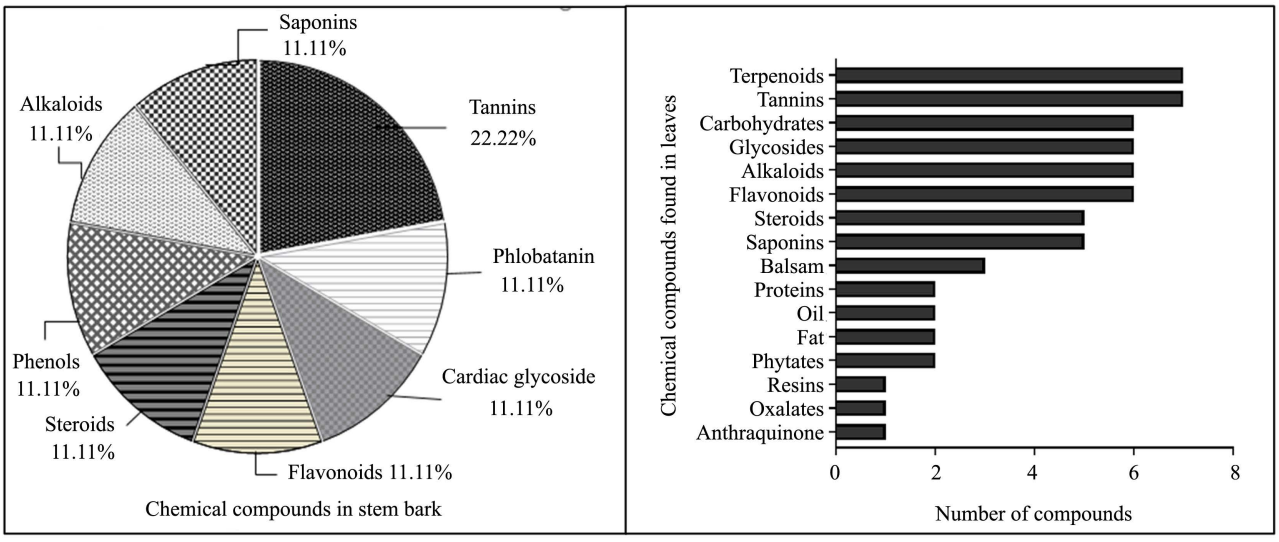
Figure 7. Rate of secondary metabolites according to the type of extract.

3.4. Chemical Composition of *N. vogelii*

From the analysis of **Table 4**, we note that few studies on the chemical composition are conducted on *N. vogelii* stem bark. The few data available show that stem bark contains alkaloids, steroids, tannins, flavonoids, phenols, saponins, phlobatanin and cardiac glycoside (**Figure 8(a)**). Some of these compounds mainly tannins, saponins, alkaloids, steroids, flavonoids are also found in the leaves of the plant (**Figure 8(b)**) and are responsible for some pharmacological

Table 4. Chemical compounds according to extracts and organs.

Extracts	Chemical compounds		References
	Leaf	Stem bark	
Petroleum ether	Alkaloids, Steroids, Tannins and Saponins	Alkaloids, Steroids, Tannins	[23]
Methanol	-	Flavonoids, Phenols, Saponins, Tannins, Phlobatanin and Cardiac glycoside	[28]
Methanol	Glycosides, Alkaloids, Saponins, Terpeniods, Steroids, Flavonoids, Resins, Proteins and Carbohydrates	-	[8]
Methanol	Saponins, Tannins, Glycosides, Flavonoids, Terpernoids, Steroids, Alkaloids, Carbohydrates, Anthraquinone, Fat and oil	-	[10] [21]
Aqueous	Tannins, Terpenoids, Glycosides, Phytate, Alkaloids, Terpenoid, Carbohydrate and Flavonoid	-	[27]
Ethanol	Tannins, Phytate, Terpenoid, Carbohydrate, and Balsam	-	[27]
Butanol	Tannins, Steroids, Glycosides, Terpenoid, Carbohydrate, Flavonoid, Oxalate and Balsam	-	[27]
Chloroform	Glycosides, Alkaloids, Terpenoid, Oxalate and Balsam	-	[27]
n-Hexane	Saponins, Tannins, Glycosides, Flavonoids, Terpenoids, Steroids, Alkaloids, Carbohydrates, Fat and oil	-	[10]



(a) (b)

Figure 8. Chemical compounds found in: (a) stem bark; (b) leaves of *N. vogelii*.

activities of the plants. According to Akpona *et al.* [6], alkaloids have action of local anaesthesia, tannins (healing, anti-bacterial, antiseptic, antioxidant, enzymatic inhibition: 5-lipo oxygenase), flavonoids (anti-inflammatory, anti-bacterial, antiviral *in vitro*), saponins (anti-bacterial, antiseptic, antiviral, anti-inflammatory, anti-oedematous and analgesic), terpenoids and steroids (antiviral, analgesic, anti-inflammatory and antiseptic). Regardless of the extract used, flavonoids, saponins, tannins, alkaloids, terpeniods, steroids are found in the leaves and/or stem bark of *N. vogelii* and the presence of the chemical compounds is not dependent on the extract. Any of the chemical compounds can be revealed by any of the extracts used in this review.

3.5. Relation between the Extracts and Chemical Compounds

Considering the Correspondence Factor Analysis (CFA), the dimension 2 (axis 2) explains 60.25% of the information contained in the axis, which is greater than 50% (**Table 5**). Therefore, we can limit ourselves to axis 2 to explain the results of the CFA.

Considering **Table 6**, we notice that the different extracts are distributed in the two axes considered (axes 1 and 2) except for petroleum ether which is not considered in them. The butanolic, ethanolic and methanolic extracts are distributed in the axis 1 contrary to the aqueous and chloroformic extracts which have a dispersion in the axis 2. We deduce that there is a strong contribution of methanolic, ethanolic and chloroformic extracts for axis 1 and axis 2 shows a better distribution of ethanolic and chloroformic and aqueous extracts. Chloroformic and ethanolic extracts are also significant for axis 1 and 2 with approximately the same dispersion diameters on both axes. The n-hexane and petroleum ether extracts are significant in axes 3 and 4 respectively (**Figure 9**).

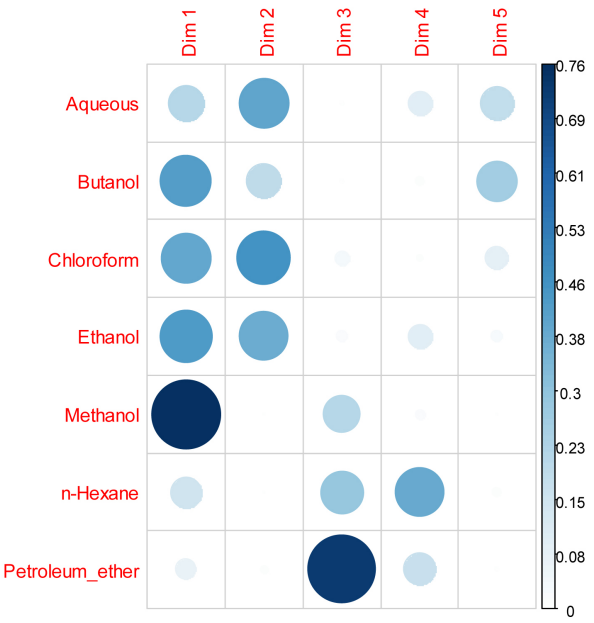


Figure 9. Importance of extracts in axis.

Table 5. Summary of models.

	Eigenvalue	variance percent	Cumulative variance percent
Dim.1	0.43179580	39.830354	39.83035
Dim.2	**0.22132679**	**20.415956**	**60.24631**
Dim.3	0.21027697	19.396683	79.64299
Dim.4	0.09888281	9.121296	88.76429
Dim.5	0.07226999	6.666436	95.43072
Dim.6	0.04953494	4.569276	100.00000

Table 6. Variables extracted according to the axis.

Extracts	Dim1	Dim2	Dim3
Aqueous	−0.43	**−0.59**	−0.05
Butanol	**−0.56**	0.38	0.05
Chloroform	−0.89	**0.96**	0.26
Ethanol	**−0.92**	−0.86	0.21
Methanol	**0.81**	0.00	0.44
n-Hexane	0.28	0.00	−0.38
Petroleum ether	0.40	0.15	−1.27

Table 7 shows the chemical compounds following the axes. From this table, we deduce that more than half of the chemical compounds are distributed in axis 1. These are mainly Balsam, Cardiac glycol, Fat, Oil, Phenols, Phlobatanin, Proteins, Resins, Saponins, Steroids and Terpeniods. The other chemical compounds: Alkaloids, Carbohydrates, Glycosides, Oxalate and Phytate are distributed in axis 2. This axis concentrates less chemical compounds than axis 1.

In conclusion, the analysis of the results from the CFA performed on the extracts and chemical compounds revealed that the first two principal components expressing 60.2% (>50%) of the original information were retained for the analysis of results. The projection of the different observations in the axis system 1 and 2 indicated that there is no specific distribution of chemical compounds according to the extracts. Thus, the aqueous ethanolic and n-Hexanic extracts located in the negative part of the axis can give chemical compounds like phylate, carbohydrates, tannins or terpernoids for the ethanolic and aqueous extracts then compounds like flavonoids, cardiac glycoside, fat, phlobatanin, phenols or oil. The positive part of the axis gathers on the one hand the extracts like methanol, petroleum ether which can give chemical compounds like alkaloids, sétroides, resins, saponins, protein or oil. On the other hand, we find the chloroformic and butanolic extracts which can give compounds like glycoside, balsam or oxalate (Figure 10).

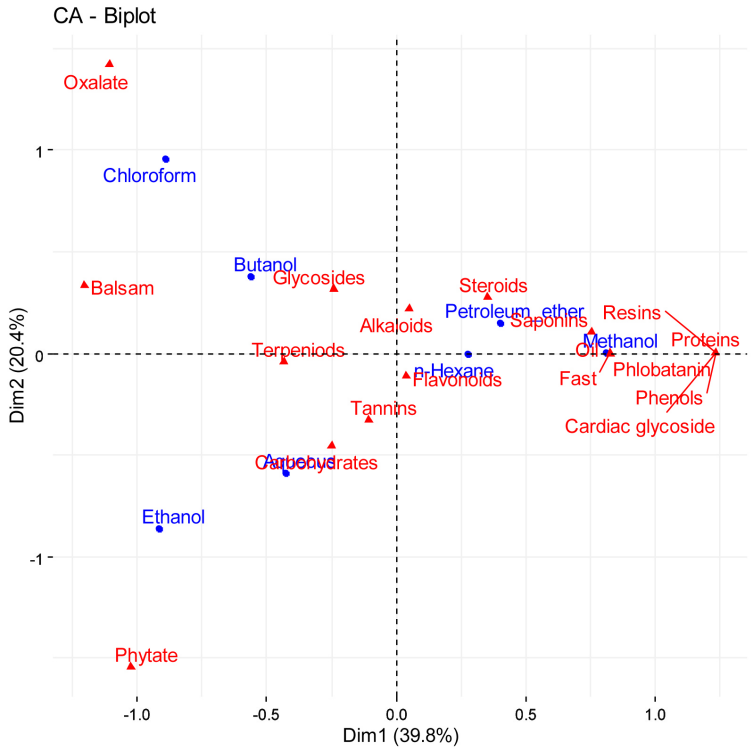


Figure 10. Relation between extracts and the chemical compounds.

Table 7. Chemical compounds variables along the axes.

Compounds	Dim1	Dim2	Dim3
Alkaloids	0.05	**0.22**	−0.44
Balsam	**−1.20**	0.34	0.38
Carbohydrates	−0.25	**−0.46**	0.11
Cardiac glycoside	**1.23**	0.01	0.95
Fat	**0.83**	0.00	0.06
Flavonoids	0.04	−0.11	0.03
Glycosides	−0.24	**0.32**	0.14
Oil	**0.83**	0.00	0.06
Oxalate	−1.11	**1.42**	0.34
Phenols	**1.23**	0.01	0.95
Phlobatanin	**1.23**	0.01	0.95
Phytate	−1.02	**−1.54**	0.17
Proteins	**1.23**	0.01	0.95
Resins	**1.23**	0.01	0.95
Saponins	**0.76**	0.11	−0.88
Steroids	**0.35**	0.28	−0.64
Tannins	−0.11	−0.33	−0.37
Terpeniods	**−0.43**	−0.04	0.19

3.6. Bioactives Compounds Identified in *N. vogelii*

In the methanol stem bark extract of *N. vogelii*, diterpene alcohol and unsaturated fatty acids were identified and are as follows: Tridecanoic acid, Pentadecanoic acid, n-Hexadecanoic acid, 9, 12-Octadecadienoic acid, 9-Octadecenoic acid, 7-Hexadecenoic acid, Phytol, Oleic acid, Octadecanoic acid, cis-10-Nonadecenoic acid and Methyl stearate. These compounds have been identified by Gas chromatography-mass spectrometry which is an analytical method that combines the features of gas-chromatography and mass spectrometry to identify different substances within a test sample [28].

4. Discussion

Only about 20 works dealing with the pharmacological properties of *N. vogelii* were retained in this study with a large part of them carried out in Nigeria. Investigation data dealing with pharmacological properties without being validated in the laboratory were not considered relevant in the present study. This is the case for the ethnobotanical investigation of plants with anti-cancer properties conducted by Soladoye *et al.* [19] among herbalists, traditional healers and sellers of herbal recipes. This study only focused on the empirical knowledge of the respondents and did not investigate further in the laboratory. The lack of selection of such data reduces the number of publications discussed in this study. Most of the studies of interest have been directed towards human medicine (90.48%) against only 9.52% for studies in veterinary medicine, yet this plant has shown good efficacy in traditional veterinary medicine through the works of Dro *et al.* [24] and Koné and Kamanzi [25]. Except Nigeria, few scientific studies have focused on this species in West Africa despite its wide distribution. It is a species with many therapeutic potentials that can be very useful in traditional veterinary medicine as a substitute for conventional drugs which for the most part have shown their limitations through ineffectiveness, high cost, counterfeiting and sometimes cases of resistance. The adoption of *N. vogelii* in traditional veterinary medicine after scientific studies that prove its efficacy would relieve the pains of many farmers who face numerous animal health problems in their herds especially parasitic diseases caused by gastrointestinal parasites that negatively affect the expression of zootechnical performance of livestock and cause serious loss of income to farmers. In line with this, the study conducted by Dro *et al.* [24] concluded that *N. vogelii* can be used as a natural antiparasitic for the control of gastrointestinal parasites of small ruminants. This study demonstrated that *N. vogelii* has a positive effect in zootechnics through the improvement of some zootechnical parameters (weight gain, correction of diarrhoea, larvicidal activity). Other researchers should follow in its footsteps to raise the level of knowledge of *N. vogelii* in ethnoveterinary application. In the listed works, leaves are more used (71.43%) than stem bark and because it is one of the plant organs that contain many secondary metabolites and whose removal does not affect the survival of the plant [31]. To evaluate the pharmacological proper-

ties, different types of extracts were made from the leaf and/or stem bark powders of *N. vogelii*. Methanol is the most used extraction solvent with 55.56%. It is the most polar solvent after water and this high polarity would be favourable for the removal of metabolites such as flavonoids, phenols, saponins, tannins, phlobatanin, cardiac glycoside, alkaloids, terpeniods, steroids, resins, proteins, carbohydrates, fat and oil much more than ethanol, butanol, chloroform, petroleum ether, n-hexane or water. Although methanol has many metabolites, its use in medicine can have side effects on human and animal health. Therefore, it would be more difficult or impossible for people with low purchasing power to have access to this solvent to prepare traditional plant-based remedies. It would therefore be appropriate to promote natural solvents such as water, which are available, non-toxic and within the reach of rural populations.

5. Conclusion

The present review has reported the pharmacological knowledge of *Napoleonaea vogelii* species in human and animal medicine. It is known for its antihelmintic, antimicrobial, antibacterial, antispasmolytic, anti-asthmatic, antitussive, anti-protozoal, anti-diarrheal and antidiabetic properties. It is rich in flavonoids, phenols, saponins, tannins, phlobatanin, cardiac glycoside, alkaloids, terpeniods, steroids, resins, proteins, carbohydrates which conferred its pharmacological properties. The documentation showed that it is a medicinal plant with many therapeutic virtues but is underused especially in veterinary medicine. There is an urgent need for further in-depth studies on this species to further expand the data available in veterinary medicine such as the evaluation of its pharmacological properties to control gastrointestinal parasites of small ruminants.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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