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Therapeutic Potential of *Ampelocissus africana* (Lour.) Merr. (*Vitaceae*) Underutilised and Indigenous Vegetables: Merging Traditional and Scientific Knowledge

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Abstract

Background: *Ampelocissus africana* is a plant widely distributed in Africa. *A. africana* is used in food through its rhizomes and fruits, but also in traditional medicine for its ability to cure a wide range of human diseases. **Aim:** This review provides an overview of traditional, phytochemical, pharmacological, toxicological, and galenic knowledge regarding the use of *A. africana*. **Methods:** Online databases such as Google Scholar, PubMed, ScienceDirect, and African Journals Online (AJOL) were used to identify relevant research on the plant. ChemDraw Professional 15.0® was used to generate the chemical structure of the compounds present in the different parts of the plant. **Results:** *Ampelocissus africana* has demonstrated therapeutic potential through pharmacological testing in several pathologies such as malaria, bacterial/fungal infections, benign prostatic hyperplasia, dermatoses, diseases with inflammatory components, diabetes, and sickle cell disease. Different classes of bioactive compounds have been identified, isolated, and quantified. Eight compounds were isolated from the rhizomes and leaves: β-sitosterol, betulin, 15-hydroxymethyl-16-methylheptadecyl ferulate, 3-hydroxymethyl-5-methyl-16-oxoheptadecyl ferulate, luteolin, derivatives of isorhamnetin and quercetin, and 1-O-β-D-rhamnopyranosyl-4-ethylphenylbut-2-one. Experimental studies have shown that *Ampelocissus africana* possesses significant anti-inflammatory, antioxidant, anxiolytic, antimalarial, antifungal, antisickling, haemolytic and anti-benign prostatic hyperplasia activity in both *in vitro* and *in vivo* models.. Toxicological studies on the extracts have proven their safety. The rhizome powder of this plant is used as an excipient in the manufacture of tablets. **Conclusion:** This literature review provides a solid scientific foundation to guide future research on *A. africana*

Major Findings: *Ampelocissus africana* exhibits a range of pharmacological activities, primarily attributed to the presence of various molecules belonging to the terpene, sterol and phenolic compound classes. However, further research is needed to better understand its effects, confirm its therapeutic value and accurately assess any potential risks associated with its use.

Keywords: *Ampelocissus africana*, Galenic Formulation, Pharmacology, Phytochemistry, Toxicology, Traditional Use

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1. Introduction

Traditional medicine remains a cornerstone of health practices in many communities around the world, providing a wealth of knowledge and resources for modern pharmaceutical science[1]. This knowledge about the use of traditional medicine has been passed down from generation to generation for thousands of years[2] and is not only adopted by people from lower socio-economic classes[3]. Although modern medicine is available in different countries, these traditional medicine systems have often been used for various historical, customary, cultural, and ecological reasons[4,5,] with a perpetual increase in the use rate[6]. They are valuable resources in low-income countries[7,8]. It is worth noting that for primary health care needs, a large part of the population in developing countries still turns to traditional medicine, which relies mainly on herbal remedies[9].

A large proportion of drugs on the market are derived from medicinal plants[10]. Quinine, vincristine, digitoxin and aspirin are all molecules derived respectively from *Cinchona officinalis*[11,12], from *Catharanthus roseus*[13–15], from *Digitalis purpurea*[16–18], from *Salix alba*[19,20], and artemisinin (antimalarial) from *Artemisia annua*[21,22] are all molecules used in modern medicine and derived from traditional medicine. These phytoactive compounds are molecules responsible for the therapeutic effects attributed to the plant[23–26]. These phytoactives are both important in the treatment of human pathologies and also facilitate several plant physiological processes[27,28]. Several families of phytocompounds are identified. Phenolic compounds, saponins, triterpenes and sterols, alkaloids, and many others can be mentioned. These bioactive compounds have an important role in liver protection, immunomodulation, anticancer, antidiabetic, anti-infectious, anti-inflammatory, antioxidant, and anti-cardiovascular activities[29–32]. The *Vitaceae* family is known for its agronomic and economic importance[33–35].

Ampelocissus is one of the most widespread genera of the *Vitaceae* family and is known to contain various secondary metabolites, such as triterpenes, phenolic compounds, and saponins. *Ampelocissus africana* (*A. africana*) is a species of the genus *Ampelocissus* widely used in Africa and also in Asia. The constituents of *Ampelocissus* have received great attention due to their multiple pharmacological actions. However, there is no comprehensive review in the literature providing concise results of phytochemical studies and pharmacological actions of this plant that can justify its use in traditional medicine. This could be justified by the few scientific studies carried out on the plant. This review aims to bring together the current state of medicinal uses, phytochemistry, pharmacological studies, toxicology, and use in galenic formulation of *A. africana* for future studies. The relationship between phytochemical components and medicinal uses in current knowledge is discussed with the aim of further accelerating research and discoveries that can be developed into modern medicines.

2. Methods

Between June and December 2024, a literature search was conducted in accordance with PRISMA guidelines in the PubMed, ScienceDirect, African Journals Online (AJOL), and Google Scholar databases to identify studies conducted on *A. africana*. The search terms (*Ampelocissus africana or Ampelocissus grantii)* and ("Traditional uses", "Phytochemicals", "Pharmacology", "Toxicology", "Galenic formulation") were used, and all articles published up to December 2024 were considered for this review. Scientific documents published in English containing keywords in the title or full text were included. The chemical structures of the isolated compounds were generated using ChemDraw Professional 15.0®.

A total of 431 articles were identified, including 329 from Google Scholar, 0 from PubMed, 75 from ScienceDirect and 27 from AJOL. During the initial screening, duplicate articles indexed in more than one database or not addressing ethnobotanical, pharmacological, phytochemical, toxicological, or galenic studies were removed, resulting in 118 articles. Only 37 articles met the study inclusion criteria after the final selection of 118 full-text articles. Of the 37 articles selected, 16 focused on phytochemical, pharmacological, toxicological, and galenic studies. The other 21 focused on botanical studies and the ethnobotanical use of the plant. The process of identifying and filtering scientific documents was carried out manually. Flow chart of the literature search used, showing the number of articles identified, reviewed, included and excluded in the review (Figure 1).

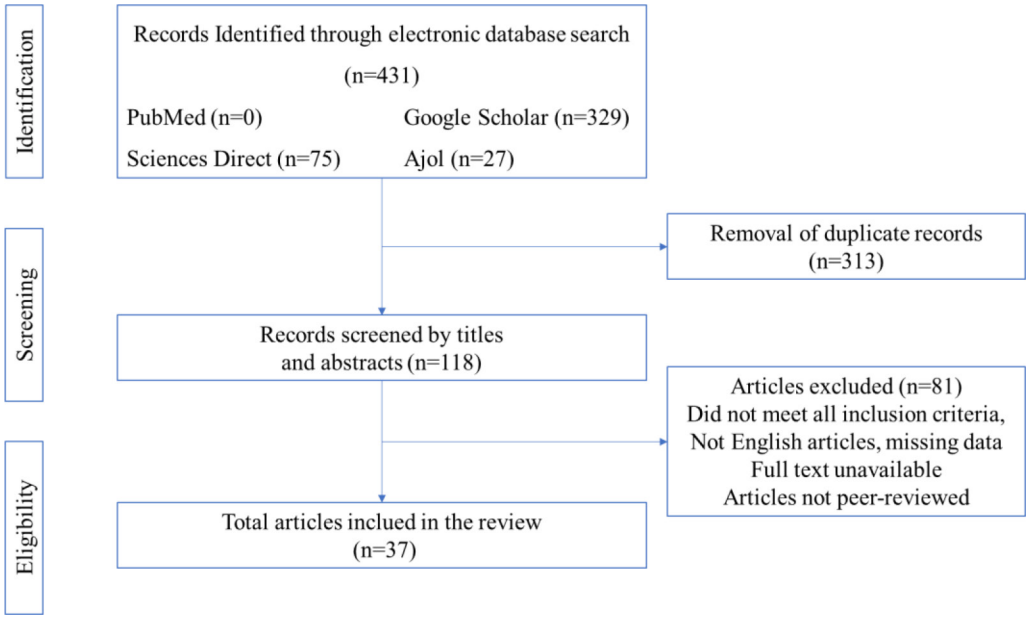


Figure 1. Flow chart of the literature search used to show the number of articles identified, reviewed, included, and excluded in the review.

3. Botany, Phytochemical and Traditional Uses

3.1. Taxonomy

Ampelocissus africana is a species of the genus *Ampelocissus* in the *Vitaceae* family. This record is from the WCSP (data provided on June 4, 2024, accepted name)[36]. Some synonyms are accepted: *A. africana* (Lour.) Steud., *Ampelopsis botria* DC., *Botria africana* Lour., *Cissus botria* Peterm., *Vitis africana* (Lour.) Spreng (World Flora Online (WFO))[36]. Two infraspecific names are accepted: *Ampelocissus africana* var. *africana* and *A. africana* var. *migeodii* Verdc[37].

From several botanical research sites, such as Plant of the World Online, the French Society of Ethnopharmacology (SFE), WFO Plant List, and Tropicos. The taxonomic hierarchy of the plant is presented in Table 1 (Figure 2).

3.2 Vernacular Names in Africa

Ampelocissus africana Lour. has different appellations depending on the countries and the languages. The vernacular names of the plant are presented in Table 2.

3.3 Morphology of *A. africana*

Ampelocissus africana (Lour.) Merr. is a climbing plant that grows mainly in tropical biomes during the dry season. This species was first accepted and published in 1935[43]. Climber or liane, or sometimes prostrate; branches densely pubescent when young or entirely glabrous, striate[44]. It occurs as a vine or creeper, or sometimes prostrate; with branches pubescent when young or entirely glabrous, ridged. The petiole of the simple leaves is about 3-13 cm long, glabrous and golden pubescent; the blade up to 8-20 cm in diameter, oval to circular, entire or slightly lobed, the margins toothed or crenate (Figure 3). The tendrils arise from the base of the inflorescence-rachis or below, with the pedicels less than 1 mm long. The seeds are about 7 × 4 mm, brown in colour and ellipsoidal in shape. The petals are about 1.5 mm long and reddish, glabrous. Stamens about half the length of the petals. Flowers in subcapitate clusters. Calyx about 1.5 mm in diameter, ± plate-shaped or cyathiform, glabrous, margin entire or shallowly lobed[45,46].

3.4 Geographic Distribution

Ampelocissus africana is native to: Benin, Botswana, Burkina, Burundi, Cameroon, Caprivi Strip, Central African Republic, Chad, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Somalia, Sudan, Tanzania, Uganda, Zambia, Zaire, Zimbabwe (Figure 4)[48–50].

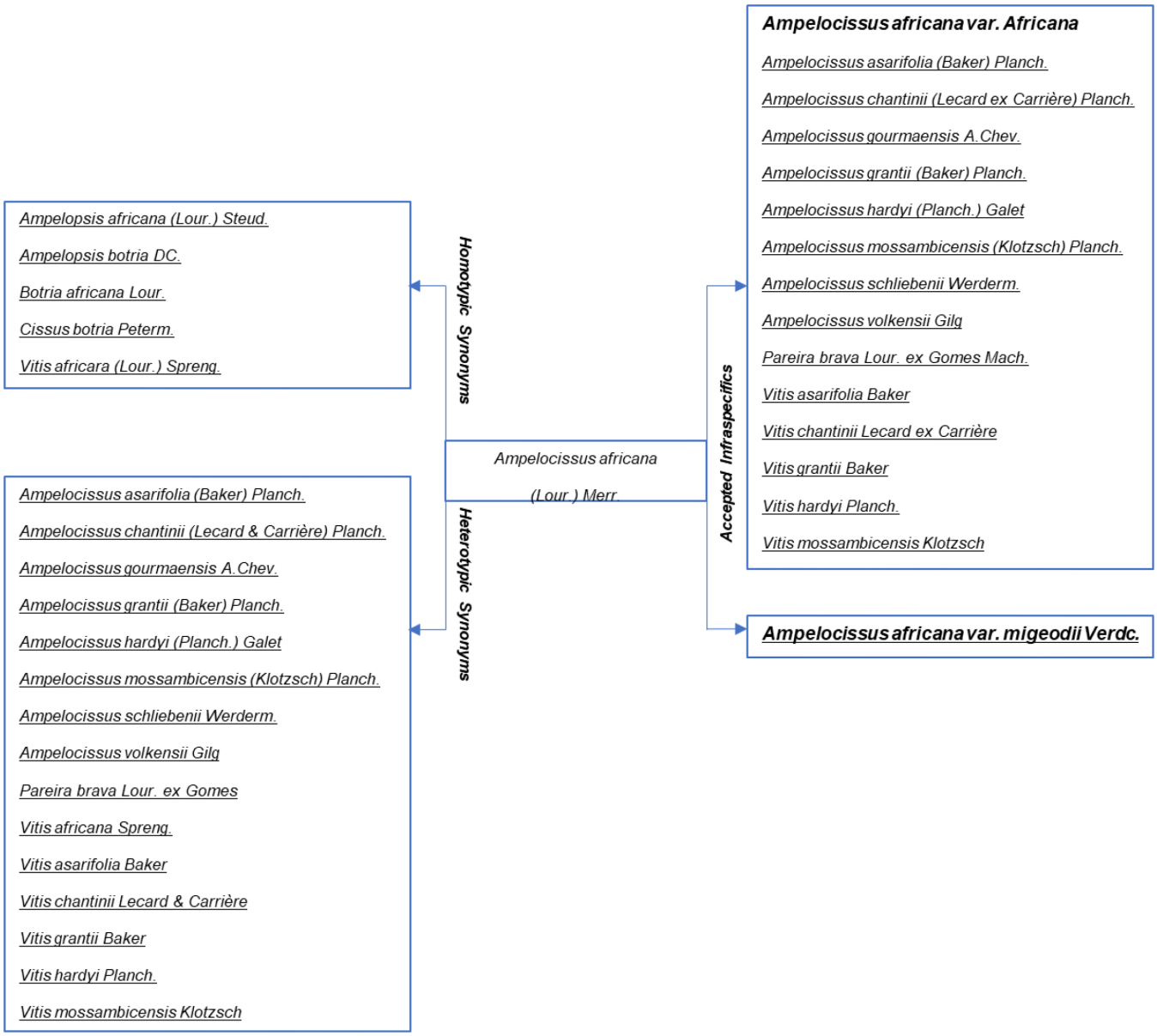


Figure 2. Taxonomy of *A. africana* (Lour.) Merr.

Table 1. Taxonomy of *A. africana* (Lour.) Merr.

Kingdom	*Plantae*
Phylum	*Streptophyta*
Class	*Equisetopsida*
Subclass	*Magnoliidae*
Order	*Vitales*
Family	*Vitaceae*
Genus	*Ampelocissus*
Species	*Ampelocissus africana*
Subspecies	*Ampelocissus africana* var. *africana* *Ampelocissus africana* var. *migeodii* Verdc.

4. Phytochemical Constituents of *A. africana*

Several phytochemical studies have been conducted, thus allowing us to identify the phytocompounds present and isolate the active molecules.

4.1 Phytocompounds Identified

The different secondary metabolites and their content in the different parts of the plant are recorded in Table 3.

Table 2. Vernacular names of *A. africana*

Country	Language	Local name	References
	French	*Vigne du Soudan*	[38]
Burkina Faso	*Moore*	*Bugsin-tungu*	[38]
Mali	*Dioula*	*Kôgho, Foroko, Faraka*	[39]
	Peulh	*Faruje bahi*	[39]
	Bambara	*Foroko farak*	[39]
	Dogon	*Bergirou quiwai*	[39]
	Haousa of Mali	*Gogododo*	[39]
Nigeria	*Haousa* of Nigeria	*Rogon daji ou Lanbi*	[40]
	Yoruba	*Eteku*	[40]
Togo	*Ewé/Mina*	*Adidoyo*	[41]
Senegal	*Manding-Bambara*	*kõgho foroko faraka*	[42]
Guinea	*Manding Mandinka*	*lassa (A Chev.; Brossart)*	[42]
Guinea	*Maninka*	*Farakanaga* or *farakanagua*	[42]
Ghana	*Dagbani*	*Enotipsi (Coull)*	[42]

4.2 Isolated Compounds

In the rhizomes, Ali 2015, in his study, isolated 4 compounds that have been the subject of analysis for

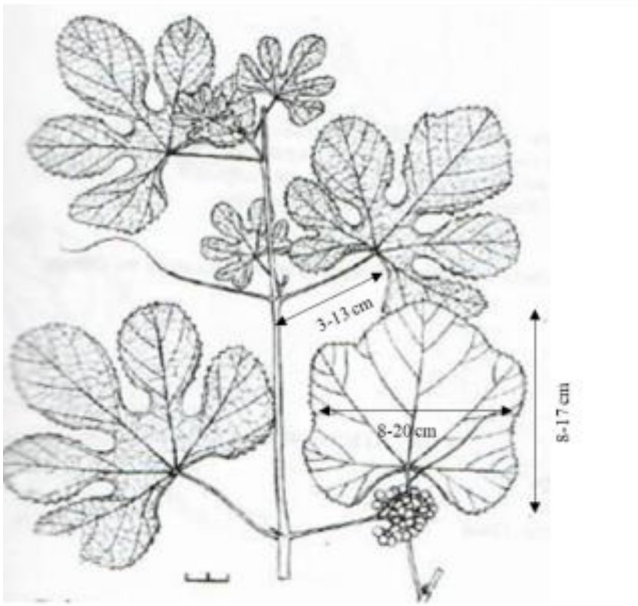


Figure 3. *Ampelocissus africana* (Lour.) Merr. (Aerial part of the plant)[47].



Figure 4. Geographic distribution of *A. africana*.

Table 3. Secondary metabolites and contents in different parts of the plant

Part Plant	Extracted Types	Phytocompounds and Contents	References
Rhizome	Acetone extract	Saponin, Triterpene, and Sterol Flavonoids (12.41mg QE/100g) Phenolics total (124.2 mg GAE/100g)	51
	Acetate extract	Flavonoids (1.455 mg GAE/g) Phenolic totals (0.196 mg GAE/g)	52
	Methanolic Extract	Phenolics (471.79 mg GAE/g) Condensed Tannins (239.21 mg/g) Hydrolyzable Tannins (15.49 mg/g) Flavonoids (24.7 mg QE/g)	5,53,54
	Aqueous extract	Phenolics 173.88 mg GAE/g Condensed Tannins 49.16 mg/g Hydrolyzable Tannins 7.55 mg/g Flavonoids 18.8 mg QE/g Sterol 104.6 mg CE/g Triterpene 119.5 mg UAE/g	
Leaves	Hydroethanolic Extract	Iridiodes (4 p.m. µg/mg AUCs/g) Polyphenol (13.38 µg/mg GAEs/g) Flavonoid (9.94 mg GAEs/g)	55
	Aqueous Extract	Oses and holosides, mucilages, Saponins, Sterols/triterpenes	56

QE: Quercetin Equivalent; GAE: Gallic Acid Equivalent; AUC: Aucubine; UAE: Ursolic Acid Equivalent.

Table 4. Chemical structures of active molecules isolated from different parts of *A. africana*

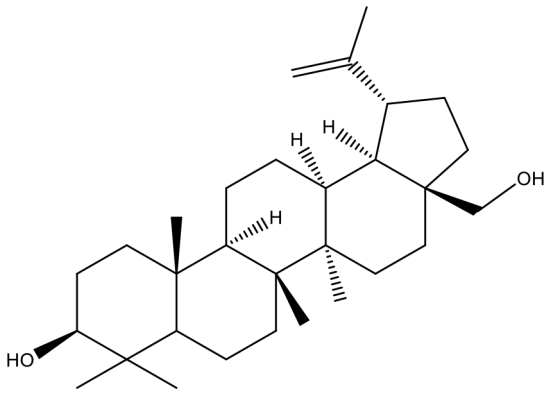
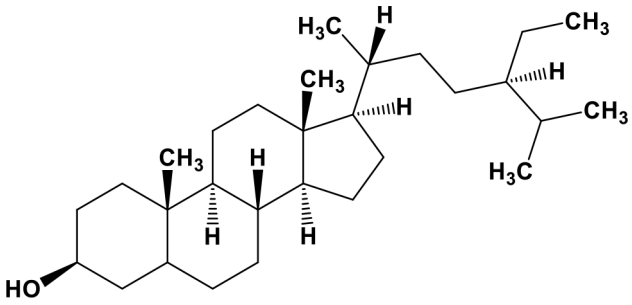
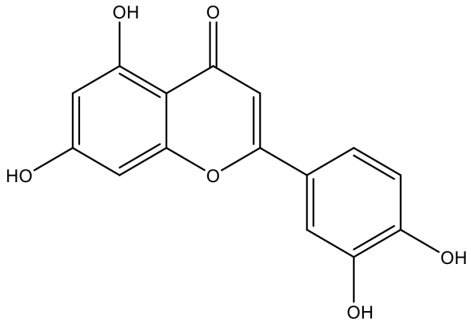
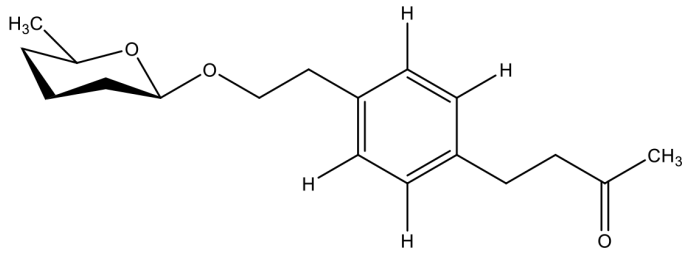
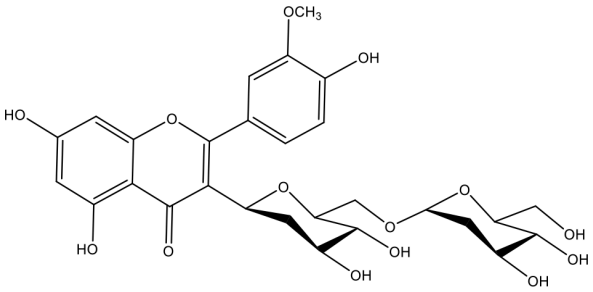
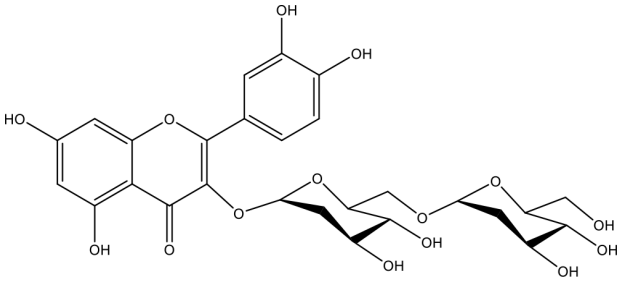
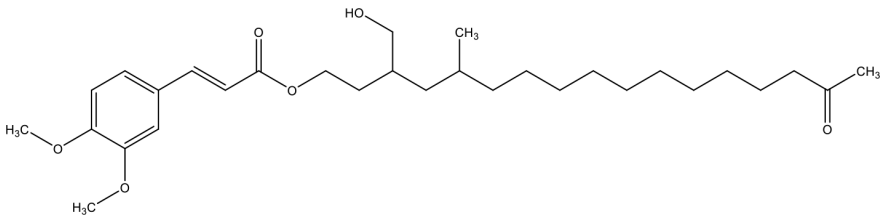
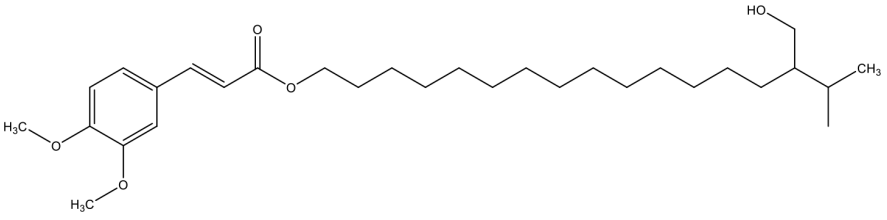
Compound Name	Chemical Structure
Betuline	
β-sitosterol	

Table 4. Continued...

Compound Name	Chemical Structure
Luteoline	
1-O-β-D-rhamnopyranosyl-4-éthylphénylbut-2-one	
Isorhamnetin 3 - O - β - D - glucopyranosyl -(1"→6") - β - D – glucopyranoside	
Quercetin 3-O- [α-L-glucopyranosyl-(1"→6") - β- D-glucopyranosyl] –4'-O-β-D-glucopyranoside	
3-hydroxymethyl-5- methyl -16-oxoheptadecylferulate	
15-hydroxymethyl-16-methylheptadecylferulate	

elucidation of structures using spectroscopic tools, mainly 1D and 2D NMR experiments: β-sitosterol, Betulin, 15-hydroxymethyl-16-methylheptadecylferulate and 3-hydroxymethyl-5- methyl -16-oxoheptadecylferulate from *A. africana* var. *africana*[52].

In the leaves, Yahaya 2016, 4 molecules identified: 3',4',5,7-tetrahydroxyl flavone (luteolin), Isorhamnetin 3 - O - β - D - glucopyranosyl -(1"→6") - β - D – glucopyranoside (flavonol), Quercetin 3-O- [α-L-glucopyranosyl-(1"→6") - βD- glucopyranosyl] –4'-O-β-D-glucopyranoside (flavonol) and phenylbutanone 1-O-β-D-rhamnopyranosyl-4-ethylphenylbut-2-one from *Ampelocissus africana* var. *africana*[40]. The chemical structures of the isolated compounds are shown in Table 4.

5. Traditional Use of *Ampelocissus africana*

The different uses in TM are summarised in Table 5 (Figure 5).

6. Pharmacological Activities of the Plant

The biological activities of *Ampelocissus africana* have been demonstrated in experimental studies. A summary of these activities is given in Table 6.

6.1 Anti-inflammatory Activity

Methanolic extracts of *A. africana* rhizomes reduced carrageenan-induced oedema at the fifth hour, with

Table 5. Traditional use of the plant in different countries

Plant Part	Medicinal Use	Preparation Method	Road Administration	Country/ References
Leaves	Maternal health care traditional	Decoction + Fruit	Oral and topical	Katsia Nigeria[57]
	Pains, feverish head and neck	Infusion + onions	Oral and Bath	Sudan[58]
	Malaria	Maceration	oral	Tanzania[59]
	African trypanosomiasis	Maceration	Oral	Mali[60]
	Wounds old (2-3 years)	Powder applied	Topical	Mali[61]
	Circulatory and Menopause disorders	Maceration	Oral	Burkina Faso[38]
Whole Plant	Cancer	Nd	oral	Nigeria[62]
	Shigellosis, Fever and Malaria	Maceration	Oral	Niger[63]
	Facilitates childbirth	Ash	Topical/ Abdomen	Nigeria[42]
Rhizomes	Ulcers and abscesses	Decoction + *Khaya senegalensis* + Soda	Oral	Nigeria[40]
	Diarrhea	Decoction	Oral	Nigeria[40,64]
	Urinary tract infection Intestinal schistosomiasis	Decoction with *Tamarindus indica* L. (leaf, bark) or fruit)	Oral	Mali / Niger[65]
	Rheumatism, articular pain	Maceration	Oral/Internal	ivory coast/ Burkina Faso[38,66]
	Haemorrhoids and infected wounds	Maceration	External/Topical	
	Increases lactation and helps with breastfeeding	Decoction	Topical/Chest	Yoruba (Nigeria)[67]
	Increased lactation and genital function	Decoction	Topical/Chest	Togo[68]
	Diarrhoea, fever, rheumatism, contraception and cancer	Maceration	Oral	Tanzania[47,48]
	Leprosy Hookworms	Decoction	Oral	
Fruits	Acidity stomach, Asthenia Diuretic		Oral	Burkina Faso[38]
	Skin rejuvenator		Topical	

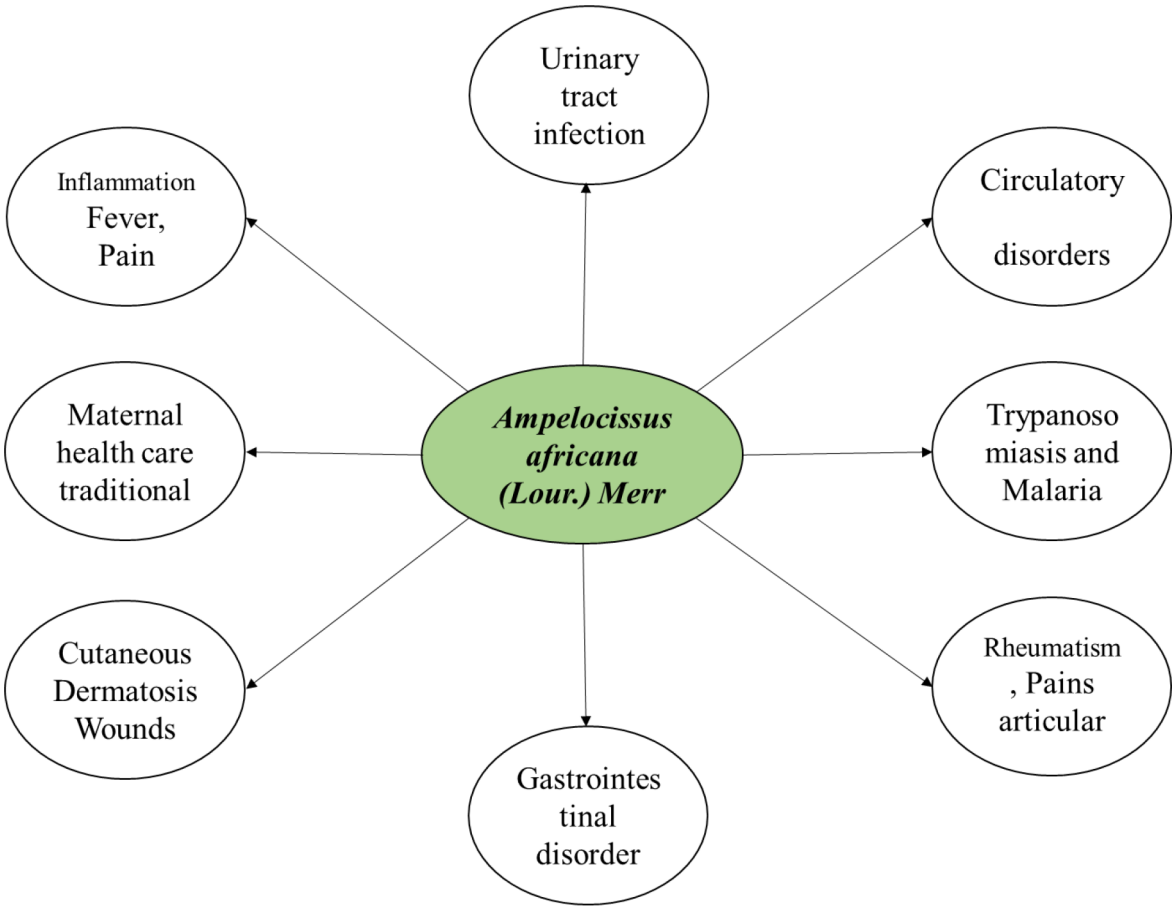


Figure 5. Traditional use of *A. africana*.

Table 6. Pharmacological activity of *A. africana*

Used parts	Extract	Biological Activities	Methods/Model Organisms Used	Result	Possible Mechanism of Action	References
Leaves	Water Methanol DCM	Trypanocide	Test *in vitro:* Long Incubation Low Inoculation Test (LILIT) The Long-Term Viability Assay (LtVA)	MIC (Water)10 µg/ml MIC (MeOH)10 µg/ml	Growth inhibition: *Trypanosoma brucei*	[60,69]
Leaves	Hydro ethanolic 50%	Antidiabetic	Test *in vitro* α-glucosidase α-amylase	% inhibition > 80% α-glucosidase Low activity α-amylase	Antidiabetic by inhibition of α-glucosidase	[55]
Leaves	Hydro-ethanolique	Alzheimer's	Acetylcholinesterase (AChE) Inhibition	2.08 mg GALAEs/g	Moderate inhibition of AChE enzymes	[55]
Leaves	Petroleum ether (PE) Ethyl acetate Water	Antimalarial	Test multidrug-resistant K1 *P. falciparum* strain and chloroquine-sensitive NF54 strain	Et Ac = 9.0 µg/mL	Antiplasmodial activity by reduction of *P. falciparum*	[59]

Table 6. Continued...

Used parts	Extract	Biological Activities	Methods/Model Organisms Used	Result	Possible Mechanism of Action	References
Rhizome	Water Acéton-Water (70/30) Ethanol-water (70/30)	Antiplasmodial	Test Chloroquine-resistant strain (K1) and Chloroquine-sensitive strain (3D7) of *P. falciparum* using pLDH assay	Aq (3D7) 3.3 g/mL EtOH (K1) 3.47 g/ml	Antiplasmodial activity by reduction of *P. falciparum*	[70]
Rhizome	Water Acéton-Water (70/30) Ethanol-water (70/30)	Antioxidant	*In vitro* trapping of 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals	Acet IC_{50} = 10.87 µg/m	DPPH radical inhibition	[51]
Rhizome	Water Aceton-Water (70/30) Ethanol-water (70/30)	Antibacterial	Disk diffusion and microdilution with Gram- and Gram+ bacteria and 1 strain of fungi	Acet IC_{50} = 0.625 mg/mL *Enterococcus faecalis* *Bacillus subtilus*	Inhibition of bacterial growth	[51]
Rhizome	Aqueous	Inhibition of hyperplasia in benign prostatic hyperplasia	Ability to inhibit hepatitis induced by testosterone administration in rats over 28 days	75.91% at dose 300mg/kg	Inhibition of benign prostatic hyperplasia Improvement of cystic areas	[54]
Rhizome	Aqueous	*In vivo* antioxidant	Malondialdehyde assay (MDA) Catalase assay (CAT) and Superoxide dismutase assay (SOD) on rat prostate after administration of testosterone for 28 days	MDA < 25 mmol/mg CAT < 25 mmol/mg SOD = 225 mmol/mg	Altered changes in antioxidant enzymes and MDA levels. CAT and SOD protect prostate cells,	[54]
Rhizome	Methanolic Aqueous	Antioxidant	Antioxidant activity ABTS, DPPH, FRAP, LPO	ABTS: 2.23µg/ml (MeOH) DPPH: 1.71µg/ml (MeOH) FRAP:87.44mmol (MeOH AAE/100g) %LPO: 52%	Reduction of ABTS, DPPH radical, and inhibition of lipid peroxidation	[53]
Rhizome	MeOH	Antiinflammatory	Inhibition Inflammation enzyme 15-lipoxygenase, COX-1, COX-2 PLA2	IC_{50} = 26.09µg/ml (LOX) IC_{50} = 36.0/100µg/ml Cox-1 IC_{50} = 38.3/100µg/ml Cox-2 IC_{50} = 26.9/100µg/ml PLA2	Proinflammatory enzymes 15-LOX, COX-1, COX-2, PLA2	[53]

Table 6. Continued...

Used parts	Extract	Biological Activities	Methods/Model Organisms Used	Result	Possible Mechanism of Action	References
Rhizome	EtOH/H_2O 80%	Antisickling	Ability to prevent red blood cells from sickling in a poor environmental oxygen environment, such as sodium metabisulfite.	% Antisickling Activity = 43%	Weak inhibition of cell sickling	[71]
Rhizome	EtOH/H_2O 80%	Anti-hemolytic power	Measure optical density at 540 nm after exposure of erythrocytes to sodium metabisulfite. If hemolysis, a cloudy solution with increased absorbance	Abs To = 0.7 Abs T60min = 0.3 Reduction of absence depending on the time	Absence of constituents causing hemolysis Protective effect of red blood cells	[71]
Rhizome	DCM/MeOH	Antifungal	*Cryptococcus neoformans*, *Candida albicans*, *Candida tropicalis* *Aspergillus niger*	*Cryptococcus neoformans* *Aspergillus niger*, MIC = 6.25 µg/ml	Inhibition of mushroom growth	[52,72]
Rhizome	DCM	Antimicrobial	*Staphylococcus aureus* *Bacillus subtilis* *Escherichia coli*, *Pseudomonas aeruginosa*	*Escherichia coli*: MIC: 25 µg/ml.	Inhibition of bacterial growth	[52]
Rhizome	Aqueous MeOH	Analgesic Peripheral	Acid Induction Acetic	Effective dose (ED_{50}) MeOH extract (183 mg/kg) Aqueous Extract (358 mg/kg)	Inhibition: bradykinin, serotonin, histamine, substance P, prostaglandins (PGE2 and PGF2)	[73]
Leaves	MeOH			Dose 300 mg/kg % inhibition 95.19%		[40]

MIC: Minimum Inhibitory Concentration; IC_{50}: 50% inhibitory concentration; Aq: Aqueux, GALAEs/g: Equivalents de Galantamine; AAE: Equivalent Acide Ascorbique; ABTS: 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid); FRAP: Ferric Ion Reducing Antioxidant Power; LPO : Lipid Peroxidation.

an inhibition percentage ranging from 69.75% for the aqueous extract to 72.90% for the methanolic extract. The effective dose (ED_{50}) values for the methanolic and aqueous extracts were 61 mg/kg and 97 mg/kg bw, respectively[56] (Table 6). Yahaya, 2016, observed inhibition in the first and third hours for the methanolic extract of *A. africana* aerial parts. This implies that the extracts could act on the release of histamine, serotonin and prostaglandin synthesis in damaged tissues[74], but also on the release of prostaglandins mediated by bradykinins, leukotrienes, polymorphonuclear cells and tissue macrophages produced by prostaglandins[57].

The mechanism of anti-inflammatory activity was investigated by determining the effect of the methanolic extract on proinflammatory enzymes phospholipase A2 (PLA2), Cox1 and Cox2. The inhibition percentages were 26.9%, 36.07% and 38.31% for PLA2, COX-1, and COX-2, respectively[53] (Table 6). Inhibition of 15-lipoxygenase (15-Lox) using method[75] resulted in an IC_{50} of 26.09 µg/mL (Table 6). The anti-inflammatory activity could therefore be due to the inhibition of

pro-inflammatory enzymes such as phospholipase A2, cyclooxygenases, and 15-lipoxygenase, which is also involved in allergic reactions. Anti-inflammatory activity was tested by inhibiting pro-inflammatory enzymes using *in vitro* assays[76–78].

6.2 Analgesic Activity

Methanolic extracts of *A. africana* rhizomes were tested for their ability to inhibit pain induced by the administration of acetic acid. The effective dose (ED 50%) values for the methanolic and aqueous extracts were 183 mg/kg and 358 mg/kg bw, respectively[73]. In Yahaya's study, the methanolic extract demonstrated dose-dependent efficacy, with the 300 mg/kg extract showing higher inhibition (95.19%)[40] (Table 6).

Acetic acid injection promotes an increase in the level of cyclooxygenase (COX) and lipoxygenase (LOX) products, thus stimulating peripheral neurons in the peritoneal nociceptive cavity, causing painful sensations through the release of various inflammatory mediators such as bradykinin, serotonin, histamine, substance P, or prostaglandins (PGE2 and PGF2). The ATP-sensitive K+ channel pathway is involved[79,80]. To verify the central analgesia of the extract, a painful stimulus was thermally induced using the hot plate test. Efficacy of the extract was obtained at the doses of 150 and 300 mg/kg[40] (Table 6).

6.3 Trypanosomiasis

To determine the activity of aqueous and methanolic extracts of the aerial part of *A. africana*, the low incubation inoculation test was performed. Trypanocidal activity was demonstrated by an inhibitory concentration of 10 µg/mL for both extracts tested[60]. Aderbauer *et al.*,[69], in their study on DCM extracts from leaves, have a weak anti-trypanosomiasis activity with a MIC of 200 µg/mL (Table 6). In the same study, fibroblast-like cells were used to observe the cytotoxic effect of the extracts compared to untreated controls during a 10-day test period. The results from this test made it possible to observe a minimal toxic concentration >500 µg/ml for the DCM extract.

6.4 Antidiabetic Activity

The antidiabetic activity was carried out *in vitro* by investigating the ability of *A. africana* to inhibit alpha-glucosidase, alpha-amylase[81] and acetylcholinesterase (AChE)[82]. Indeed, glucose is the result of the hydrolysis of oligosaccharides and disaccharides by alpha-glucosidase, which promotes their development in cells and can lead to hyperglycemia in diabetics. In contrast, maltose and glucose result from the hydrolysis of polysaccharides and oligosaccharides by alpha-amylase[83,84]. The 50% hydroethanolic extract showed low activity against alpha-amylase but much more pronounced activity, therefore very active on α-glucosidase, with an inhibition percentage greater than 80%[55] (Table 6).

6.5 Antimalarial Activity

The ethyl acetate fraction of *A. africana* leaves was tested *in vitro* on the multidrug-resistant *P. falciparum* K1 strain. The inhibitory concentration on this strain was estimated at 9 µg/mL, demonstrating antimalarial potential[59] (Table 6).

6.6 Microbial Activity

Zongo *et al.*, have tested *in vitro* on aqueous extracts, hydroacetonic 70% and hydroethanolic 70%[51]; the antimicrobial activity has been determined according to the method of Bauer *et al*[85]. A disk diffusion and broth microdilution assay was performed against 9 strains of reference bacteria, including Gram-negative and Gram-positive bacteria and 1 fungal strain. The extract Hydroacetone has proven to be more effective against *E. faecalis* and *B. subtilus* with an IC_{50} of 0.625 mg/mL (Table 6).

The ethyl acetate extract of the rhizomes was effective against *E. coli* with a minimum inhibitory concentration (MIC) of 25 µg/mL[52]. Two molecules isolated from this extract were more effective. 15-Hydroxymethyl-16-methylheptadecylferulate is active against *S. aureus*, *B. subtilis* and *P. aeruginosa* with a MIC of 50 µg/mL. 3-Hydroxymethyl-5-methyl-16-oxoheptadecylferulate is active against *E. coli* and *P. aeruginosa* with a MIC of 12.5 µg/mL and 25 µg/mL, respectively[52] (Table 6). Maiyama *et al.*, on the methanolic extract of the roots of the plant, obtained efficacy against the same germs (*E. coli* and *P. aeruginosa*)[72].

6.7 Antifungal Activity

15-hydroxymethyl-16-methylheptadecylferulate (Molecule isolated from the ethyl acetate extract of the roots) is active against *C. neoformans*, *A. niger* and

C. albicans with a MIC of 6.25 µg/ml. 3-hydroxymethyl-5-methyl-16-oxoheptadecylferulate has efficacy against *C. neoformans* and *C. tropicalis* with a MIC = 12.5 µg/ml[52] (Table 6).

6.8 Antisickling Activity

Sickle cell anaemia is an inherited disease that affects haemoglobin. According to the WHO, sickle cell disease is one of the most common genetic diseases in the African region[86]. Bahari *et al.,* tested the anti-sickle cell activity of 3 plants, including *A. africana*[71]. *A. africana* anti-sickling activity is defined as its capacity to stop red blood cells from falcifying in an oxygen-poor environment, like sodium metabisulphite[87]. At a dose of 25 mg/ml of the hydroethanolic macerate of the rhizome bark, the percentage of anti-sickling activity was estimated at 43% (Table 6).

6.9 Hemolytic Activity

To determine the antihemolytic effect, erythrocytes were exposed to 2% sodium metabisulfite[87–90] in the presence of the hydroethanolic macerate of *A. africana* rhizome bark. An increase in density of the mixture indicates an increase in the content of haemoglobin outside the cells and, therefore, hemolysis. The presence of the hydroethanolic macerate allowed a decrease in absorbance from 0.7 to 0.3 after 120 min (Table 6). This decrease in absorbance testifies to the effect protector of red blood cells by the extract[71].

6.10 Antihyperplasia Benign Prostatic Hyperplasia

Benign prostatic hyperplasia in the study of Kabré *et al.,*[71] was induced by the administration of testosterone for 4 weeks. The percentage of inhibition of the aqueous extract was proportional to the dose of extract used. At the dose of 300 mg/kg, the percentage of inhibition was estimated at 75.91%[54] (Table 6). The histological section showed an improvement in the development of cystic areas produced by testosterone, with an architecture tending towards normal in comparison with untreated negative controls[54].

6.11 Antioxidant Activity *In Vitro*

Kabré *et al.,* measured the *in vitro* antioxidant capacity of methanolic and aqueous extracts. Four methods were used. These included the inhibition of the DPPH radical and the ABTS radical, and the capacity to inhibit lipid peroxidation. The methanolic extract was more effective, with an inhibitory concentration of 2.23 µg/ml and 1.71 µg/ml for the inhibition of the ABTS and DPPH radicals, respectively (Table 6). The inhibition of lipid peroxidation confirmed the activity of the methanolic extract, with 52% inhibition of lipid peroxidation[53].

Oxidative stress resulting from the induction of benign prostatic hyperplasia from the administration of testosterone was evaluated by the dosage of oxidation markers. In the literature, the onset of oxidative stress is manifested by an increase in malondialdehyde (MDA) accompanied by a decrease in the activity of the antioxidant enzymes catalase (CAT) and superoxide dismutase (SOD)[91]. These markers were measured in the ground prostate. A significant decrease in SOD was noted in sick rats (BPH) compared to the group of rats treated with the extract at a dose of 300 mg/kg. The same observation was made with the dosage of CAT, which increased in rats treated at a dose of 300 mg/kg. The activity of the aqueous extract promotes an increase in CAT and SOD enzymes, whose main role is to protect the body against lipid peroxidation[54].

6.12 Anxiolytic Activity

Some key parameters of mouse anxiety (central zone and segment opening time, reduction in mean uprighting and stretching postures) were used to determine the anxiolytic effect of the aqueous extract of the whole plant of *A. africana* at doses of 50, 100, and 500 mg/kg. The aqueous extract has moderate dose-dependent anxiolytic activity[92].

6.13 Acetylcholinesterase Inhibitor AChEI

Acetylcholinesterase (AChE) is involved in neurodegenerative diseases. Some drugs used in modern medicine to treat these pathologies act by inhibiting AChE (Donepezil, Rivastigmine, Galantamine). Bello *et al.,* in their study, demonstrated that the hydroethanolic extract of *A. africana* leaves has a moderate inhibitory activity on AChE with an inhibitory concentration of 2.08 mg GALAE/g of extract[55] (Table 6).

7. Use in Galenic Formulation

Preliminary characterisation studies of *A. africana* tuber starch reveal carbohydrates, fibre, protein, and fat

content of 84.54%, 5.5%, 4.46%, and 1.5%, respectively. Modified *A. africana* starch is used as an excipient in the development of solid oral dosage forms[93]. The study of the macroscopic characteristics of *A. africana* reveals a fine texture and a light ash colour, without odour. Under the microscope, a spherical or oval granular morphology is observed[93].

Native starches, particularly tuber starch *A. africana*, are limited in their use due to instability in terms of changes in temperature, pH, and shear forces[94]. Changes are carried out to improve these properties by using these powders to formulate galenic forms. The modification is carried out on the rearrangement of the molecular structure of the starch through oxidation reactions or group substitution of functional groups on the molecule. Studies have proven that acetylation of starch improves the properties of the powder in its use in the formulation of solid forms[95,96].

In his study, Hassan modified[97] *A. africana* starch powder by the acetylation method[98–100]. Characterisation of acetylated starch revealed that the powder was odourless and tasteless, off-white in colour with low ash content. Iodine test indicated starch content of 10.12%. Scanning electron microscopy (SEM) analysis revealed that the starch was globular and oval. In the direct compression tablet development process, modified starch could be used as a binder[101].

The tubers of *A. africana* are used for their properties as binders and disintegrants in the formulation of tablets. Indeed, according to a study by Aminu *et al.*,[102] tablets of ibuprofen prepared with the powder of the tubers of *A. africana* have permitted obtaining tablets with a disintegration time of 1.93 min (Starch Tubercule *A. africana*) and 3.82 min (Starch Tubercules *A. africana* acetylated). Friability was 0.70% for both tablet forms. However, the content in ibuprofen tablets (Amidon Tubercules *A. africana*) was 78.96% and 95.14% (Amidon *A. africana* acetylated). A chemical modification by acetylation of native tubers (*A. africana*) leads to an improvement in the properties of the powder. Therefore, acetylated native tubers can be used as an excipient for effective oral drug delivery[102].

Due to its binding and disintegrating properties, the acetylated powder of *A. africana* could be used in the manufacture of dry oral forms (tablets, capsules, granules).

8. Acute Toxicity

Going through the acute toxicity class method of the guidelines of the Organisation for Economic Cooperation and Development (OECD, 2001)[103], the OECD toxicity test was conducted with the aqueous and methanolic extracts of *A. africana* rhizomes, and no signs of toxicity were reported at a dose of 2000 mg/kg. The extracts of this plant are classified in the 5th toxicity class with weak acute oral toxicity and an LD_{50} value estimated at 5000 mg/kg bw[73].

9. Conclusion

This review highlights *A. africana*, a medicinal plant used in traditional medicine to treat several pathologies. It is potentially pharmacologically important, supported by various publications. Its potential is due to the constituent's phytochemicals, which contribute to its activities from a pharmacological. However, some authors attribute *A. grantii* or *Cissus okoutensis* Berh. It is found everywhere in West, Central, and Southern Africa. Its phytochemical composition reveals the presence of several secondary metabolites, such as phenolic totals, flavonoids, tannins, triterpenes, sterols, and coumarins. Some researchers have isolated molecules that, after studies, have been able to confirm their pharmacological activity. An inventory of articles on the plant allowed us to assess the various pharmacological activities that may justify its traditional use. Investigations into the toxicity of plant extracts demonstrated that aqueous and methanolic extracts have low toxicity via oral and intraperitoneal routes. Finally, starch acetylated from the plant's rhizomes was used as a binder and disintegrant in tablet formulation. The tablets obtained complied with pharmaceutical standards, thus confirming the properties of starch from the rhizomes of *A. africana*. The data obtained from the plant constitutes a database for researchers, opening the way for exploration and future use in clinical practice and the pharmaceutical industry.

10. References

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Author Contribution

BCA: Study concept and design; BCA, IBS: Writing of the article; SO, TKT, EBK, RS: Critical revision for important intellectual content. All authors have read and agreed to the published version of the manuscript.