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Anacardium occidentale as a potential source of bioactive compounds for the treatment of diseases in Africa

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Abstract

Plant extracts have been used for medicinal purposes for centuries, long before the development of synthetic pharmaceuticals. In recent years, interest in plant-based remedies has increased because they are often associated with fewer adverse effects. Traditionally, medicinal plants and herbs have played a central role in folk medicine for the treatment of numerous ailments. Among these plants, *Anacardium occidentale* is widely recognized in Africa, where its leaves, stem bark, fruits, and seeds are commonly used in the traditional management of conditions such as diabetes, hypertension, gastrointestinal disorders, infections and inflammation. Several studies have reported presence of diverse secondary metabolites in *Anacardium occidentale*, which are believed to contribute to its various biological activities. Several biological activities of extracts obtained from different organs of *Anacardium occidentale* have been investigated, including anti-inflammatory, antimicrobial, antidiabetic, anesthetic, antioxidant, insecticidal, antidiarrheal, and hypolipidemic effects. These studies have revealed promising and noteworthy pharmacological properties. In addition, symbiotic endophytic fungi associated with different parts of the plant may also produce bioactive compounds with potential therapeutic value. Therefore, *Anacardium occidentale* represents an important medicinal resource whose thorough scientific investigation could enhance valorization of traditional knowledge and support the development of innovative biomedical and pharmaceutical applications.

Keywords: *Anacardium occidentale*; Ailiments; Phytochemicals; Biological activities

1. Introduction

Medicinal plants are important natural products in drug discoveries due to their pharmacological activities. Medicinal plants have become an element of international importance both in term of medical and economic benefit [1]. Plant materials are major source of drugs. They are readily available and affordable [2]. Plants have been the basis for medical treatments through much of human history and such traditional medicine is still widely practiced today [3]. Traditional herbal medicines are naturally-occurring, plant-derived substances with minimal or no industrial processing that are used to treat illness within local or regional healing practices [4]. Plants extracts have been used for medical purposes for a very long time in contrast to synthetic pharmaceuticals. This strategy has been promoted recently since it has fewer negative consequences [5]. Several powerful and effective drugs that are used medicinally in various nations come from plants. Examining medicinal plants potential for therapeutic use is of great interest to researchers. *Anacardium occidentale* is a plant with therapeutic qualities in all of its parts. It is a plant that has long time been used

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for therapeutic purposes, including the capacity to treat inflammation, diabetes, microbial infections, hyperlipidaemia and hypertension [6]; [7]; [8]; [9]. *Anacardium occidentale* leaf is consumed in other parts of the world as a refreshing drink for culinary purposes in delicacy. In Chad, Benin, Guiney, Mali and Cameroon leaves and stem barks of this plant are also used in traditional medicine [10]. *Anacardium occidentale* seeds contain a high concentration of bioactive substances, including phenols, flavonoids, and essential fatty acids, which have been shown to possess potential antioxidant and anti-inflammatory properties. Its root barks treat hypertension and malaria, while its leaves heal wounds and infections [11]; [12]; [13]. *Anacardium occidentale* leaf possess medicinal benefits and have been used as remedy for both diarrhea and colic [14]. *Anacardium occidentale* leaf extract is utilized to reduce blood sugar and blood pressure levels. *Its* apple has anti-inflammatory, antimicrobial properties; *Anacardium occidentale* nuts contain antioxidants, phenols and beneficial compounds [15];[16]. A variety of ailment, including diarrhea, colic, toothache, diabetic, skin conditions, inflammation, hypotension, infertility and impotence, can be treated with extracts made from its several parts, including leaves, stem, bark, kernel, flowers, fruits and roots [17]. This bibliographic review provides an analysis of previous studies on *Anacardium occidentale* in order to open new perspectives for better valorization of this plant in African traditional medicine.

2. Data collection methodology

A comprehensive literature search was carried out using the databases Scopus, Elsevier, PubMed, Google Scholar and ResearchGate. To ensure a broad and inclusive selection of relevant publications, no restrictions were applied regarding language or year of publication. The selected publications primarily addressed the botanical characteristics of *Anacardium occidentale*, its applications in traditional medicine, biologicals activities and chemical composition of its various plant organs.

2.1. Botanical description

Anacardium occidentale is an agroforestry species belonging to the *Anacardiaceae* family. *Anacardium occidentale* is a tropical tree up to 12 m high, generally branched at the base, with a ball-shaped habit [18];[19]. Leaves are simple, alternate, entire, obovate or obovate-oblong, leathery and glabrous on both sides. It has a taproot system that can reach a depth of two meters [20]. *It* is a woody species native to South America, more specifically to the Ceara region in northeastern coastal Brazil [21]. It was introduced into West Africa and Senegal as a species for afforestation and reforestation before becoming an agricultural crop and now represents an important source of income for rural populations [22]. The phylogenetic classification of the *Anacardium occidentale* tree according to the angiosperm phylogeny system is presented in Table 1.

Table 1 Systematic position of *Anacardium occidentale* [23]

Rank	Taxon
Reign	Vegetable
Division	Magnoliophyta
Branch	Spermatophytes
Sub-branch	Angiosperms
Class	Dicotyledonous
Order	Sapindales
Sub-order	Anacardiineae
Family	Anacardiaceae
Tribu	Anacardieae
Genus	Anacardium
Species	*Anacardium occidentale*

2.1.1. Anacardiaceae family

Anacardiaceae family currently comprises approximately 83 genera and around 860 recognized species [24]. It is organized into five main tribes: Anacardieae, Spondiadeae, Semecarpeae, Rhoeae, and Dobineae. The tribe Anacardieae includes eight genera: Androtium, Buchanania, Bouea, Gluta, Swintonia, Mangifera, Fegimanra, and Anacardium.

Species of the genus Anacardium are listed in Table 2 with their country of origin

Table 2 Different species of the genus Anacardium [25]

Botanical name	**Country of origin**
Anacardium brasiliense Barb. Rodr	Brazil
Anacardium curatellaefolium St.Hil	Brazil
Anacardium encardium Noronha	Malaysia
Anacardium giganteum Hancock ex.Engl	Brazil
Anacardium humile St. Hil	Brazil
Anacardium mediterraneum Vell. Fl. Flum	Brazil
Anacardium nanum St. Hi	Brazil
Anacardium occidentale L	Brazil
Anacardium rhinocarpus D.C. Prod.	Brazil
Anacardium microsepalum Loes.	Amazon region
Anacardium corymbosum Barb. Rodr	Brazil
Anacardium excelsum Skeels	Brazil
Anacardium parvifolium Ducke	Amazon region
Anacardium amilcarianum Machado	Brazil
Anacardium Kuhlmannianum Machado	Brazil
Anacardium negrense Pires and Fro'es	Brazil
Anacardium rondonianum Machado	Brazil
Anacardium tenuifolium Ducke	Brazil
Anacardium microcarpum Ducke	Amazon region

2.2. Phytochemicals of Anacardium occidentale

Table 3 Phytochemicals of *Anacardium occidentale* Leave and stem bark

Secondary metabolites	**[32]**	**[28]**	**[27]**	**[26]**	**[29]**		**[30]**	**[33]**	**[31]**		**[35]**	**[32]**
	Le	Le	Le	Le	Le	St	Le	Le	Le	St	Le	Le
Phenolic	+	+	+	+	+	+	+	+	+	+	+	+
Alkaloids	+	+	+	-	+	+	+	+	+	+	-	+
Flavonoids	+	+	+	-	+	+	+	+	+	+	+	+
Tannins	+	+	+	+	+	+	+	+	+	+	+	+
Anthraquinolones	-	+	ni	ni	ni	ni	ni	-	ni	ni	ni	ni
Steroids and triterpenes	+	+	+	-	+	+	+	-	+	+	+	+
Glycosides	-	+	ni	-	ni	ni	+	-	+	+	-	+

Saponins	-	+	ni	+	+	+	+	+	+	+	+	+
Quinones	ni	ni	+	ni	ni	ni	ni	ni	+	+	ni	ni
Coumarins	ni	ni	ni	ni	+	+	ni	ni	ni	ni	ni	ni
Reducing sugar	ni	ni	ni	ni	ni	ni	ni	+	ni	ni	ni	ni
Proteins	ni	ni	ni	ni	ni	ni	ni	ni	+	+	ni	ni
Carbohydr Ate	ni	ni	ni	ni	ni	ni	ni	ni	+	+	+	+

Legends:+= present; - =Absent; ni=not investigated; Le=*Anacardium occidentale* Leave; St =*Anacardium occidentale* stem bark

Table 3 contains the secondary metabolites identified from the organs of Anacardium occidentale collected in several countries. This review shows that the metabolites vary depending on the locality of collection within the same organ and from one organ to another. The richness in secondary metabolites of the organs of *Anacardium occidentale* could justify its use in traditional medicine. In the leaves of *Anacardium occidentale* collected in Ondo State (Nigeria), Ganiyu *et al*. [26] reported the absence of flavonoids, alkaloids, steroids, and terpenes, whereas these metabolites have been reported by other authors [27];[28]; [29]; [30]; [31]. However, in most studies, tannins and flavonoids have been identified [32];[27];[29];[33];[30];[31];[34]. Similarly, in several previous studies, saponins, steroids, and terpenes have also been reported [28]; [29];[35]. The variation in secondary metabolites observed in previous studies could be related to the harvesting period, the nature of the soil, or climatic factors [36];[37]; [38].

2.3. Proximate composition of *Anacardium occidental* leave and stem bark

The proximate composition of the leaves and stem bark of *Anacardium occidentale* is presented in Table 4. In the leaves of *Anacardium occidentale*, the moisture content ranges from 14.00% to 39.72% [30];[33];[31], whereas in the stem bark it ranges from 4.45±0.07% to 6.12±1.01% [39];[31]. Regarding the ash content, it is around 3.53–3.50 ± 0.09% in the leaves [30];[33];[31], while the ash content of the stem bark of *Anacardium occidentale* ranges from 2.51±0.09% to 3.94±0.09% [39];[31]. As for the crude fat content, a notable variation ranging from 8.96 to 24.00±1.20% is observed in the leaves of *Anacardium occidentale* [30];[33];[31], with a nearly constant value in the stem bark (5.50±1.20%) [31];[39]. Concerning the crude fibre content, it ranges from 3.40 ± 0.09% to 14.97% in the leaves [30]; [33], whereas in the stem bark it ranges from 1.50±0.09% to 1.90 ± 0.05% [30]; [31]. With regard to crude protein content, a notable variation is observed among the results reported in previous studies. The variation in the proximate composition of the organs of *Anacardium occidentale* could be explained by factors such as the period and location of collection, age of the plant, nature of the soil, and climatic conditions [40];[41].

Table 4 Proximate composition of *Anacardium occidentale*

Proximate Composition	[30]	[33]	[39]	[31]	
	Leave	Leave	Stem bark	Leave	Stem bark
Moisture content (%)	14.00±1.01	39.72	4.45± 0.07	14.00±1.01	6.12±1.01
Ash content (%)	3.50± 0.09	3.48	3.94± 0.09	3.50±0.09	2.51± 0.09
Crude fat (%)	24.00±1.20	8.96	4.31 ± 0.07	24.50±1.20	5.50±1.20
Crude fibre (%)	3.40±0.09	14.97	1.90 ± 0.05	3.50± 0.09	1.50±0.09
Crude protein (%)	0.12± 0.00	13.95	9,90± 0.13	0.14±0.00	1.15± 0.00

2.4. Mineral composition of *Anarcadium occidentale* Leaves and stem bark

The mineral contents of the leaves and stem bark of *Anacardium occidentale* are presented in Table 5. The analyses indicate that the leaves contain considerable amounts of certain mineral elements, particularly calcium (768.00±5.78%), magnesium (114.00±1.84%), potassium (640.00±21.27%), and sodium (168.00±24.06%)[33]. Furthermore, the stem bark of *Anacardium occidentale* also contains several essential minerals, with contents of 4.89 ± 0.93 for magnesium, 6.04±0.43 for potassium and 2.47±0.07 for iron [39]. Lower amounts were observed for zinc (0.21± 0.02) and copper (0.10±0.01) [39].

Table 5 Mineral composition of Anarcadium occidentale leaves

Mineral	Leave [33]	Stem bark [39]
Ca	768.00±5.78	-
Mg	114.00±1.84	4.89 ± 0.93
K	640.00±21.27	6.04 ± 0.43
Na	168.00±24.06	-
Fe	-	2.47±0.07
Zn	-	0.21±0.02
Cu	-	0.10±0.01

2.5. Compounds present in *Anacardium occidentale* ethanol stem bark extracts

The analysis of table 6 highlights the identification of 17 bioactive compounds, with retention times ranging from 9.840 to 31.429 minutes [39]. This broad retention time range reflects the presence of molecules with diverse chemical structures and varying molecular weights [39]. The results indicate a predominance of saturated and unsaturated fatty acids, along with several fatty acid esters [39]. These esters may arise from natural chemical transformations, or from conditions associated with the analytical procedure, and they are known for their potential biological and industrial applications. Furthermore, most of the detected compounds appear between 15 and 21 minutes, suggesting that the dominant molecules share relatively similar physicochemical characteristics, particularly in terms of polarity and molecular mass [39]. Compounds detected after 30 minutes generally correspond to heavier or less volatile molecules. Overall, the analyzed sample is characterized by a high abundance of fatty acids and their derivatives, which are bioactive compounds that may contribute to the pharmacological properties of *Anacardium occidentale*, including antimicrobial, anti-inflammatory, antioxidant, cardioprotective and antihypertensive activities.

Table 6 Bioactive compound present in *Anacardium occidentale* ethanol stem bark extracts by GC-MS [39].

Retention time	Bioactive components
9.840	5-Octadecene
12.828	2-butylthio-pyrimidine-4,6(3H, 5H)-dione
12.893	Trichloroacetic acid, pentadecyl ester
13.113	Dodecanoic acid
15.408	Tetradecanoic acid
16.880	Carbonic acid, propyl 2, 2,2-trichloroethyl ester
16.952	Hexadecanoic acid, methyl ester
17.410	n-Hexadecanoic acid
18.743	10-Octadecenoic acid, methyl ester
18.98	Heptadecanoic acid, 16-methyl, methyl ester
19.301	Linoelaidic acid
19.497	Octadecanoic acid
19.753	9,12-Octadecadienoic acid
20.137	Linoelaidic acid
20.900	6-Octadecenoic acid
30.931	Oleic acid
31.429	Ethyl oleate

2.6. Amino acid profile composition of *Anacardium occidentale*

The amino acid profile of the stem bark of *Anacardium occidentale*, expressed in g/100g of protein, reveals a relatively diverse composition, highlighting a substantial presence of both essential and non-essential amino acids. Glutamate (14.46±0.10g/100 g) emerges as the most abundant amino acid, followed by aspartate (10.65±0.09g/100 g), lysine (9.72± 0.07g/100 g), and leucine (8.98±0.10g/100g) [39]. This high proportion of acidic amino acids (glutamate and aspartate) suggests that stem bark proteins may play a significant role in cellular metabolism and protein synthesis. Several essential amino acids are present in appreciable amounts, indicating that the stem bark proteins of *Anacardium occidentale* possess promising nutritional value, as these amino acids must be supplied through the diet. Amino acids such as alanine (6.29g/100g), arginine (6.55g/100g), glycine (4.21g/100g), and serine (4.33 g/100 g) are found at intermediate levels, contributing to key biological functions including protein synthesis, metabolic regulation, and tissue formation. The lowest concentrations are observed for tryptophan (1.12±0.01g/100g), cystine (1.42±0.02g/100g), and methionine (1.50±0.03g/100g). Despite their modest levels, these sulfur-containing and aromatic amino acids are vital for antioxidant mechanisms and maintaining protein structure.

Table 7 Amino acid profile compositions (%) of *Anacardium occidentale* stem bark [39]

Amino acid (g/100g protein) of stem bark			
Glycine	4.21±0.04	Lysine	9.72 ± 0.07
Alanine	6.29 ± 0.08	Methionine	1.50 ± 0.03
Serine	4.33 ± 0.02	Glutamate	14.46 ± 0.10
Proline	3.03 ± 0.02	Phenylalanine	3.91 ± 0.09
Valine	4.65 ± 0.04	Histidine	3.37 ± 0.04
Threonine	4.34 ± 0.09	Arginine	6.55 ± 0.07
Isoleucine	4.60 ± 0.04	Tyrosine	2.92 ± 0.02
Leucine	8.98 ± 0.10	Tryptophan	1.12 ± 0.01
Aspartate	10.65 ± 0.09	Cystine	1.42±0.02

2.7. Composition of essential oil from *Anacardium occidentale* leave

Table 8 outlines chemical composition of essential oil extracted from the leaves of *Anacardium occidentale*. The analysis highlights a rich diversity of volatile constituents, predominantly composed of terpenes, especially monoterpenes and sesquiterpenes, alongside smaller amounts of esters and oxygenated compounds [42]. Compounds with retention indices ranging from 939 to approximately 1100 are mainly monoterpenes, including α-pinene, β-pinene, myrcene, α-phellandrene, δ-3-carene, α-terpinene, p-cymene, and α-terpinolene [42]. Known for their high volatility, these molecules typically form the dominant aromatic fraction of essential oils. Their presence suggests that the studied oil exhibits a fresh, resinous, and slightly citrus-like aroma. Furthermore, several of these monoterpenes are associated with notable biological activities, such as antimicrobial, anti-inflammatory, and antioxidant effects. In the intermediate range of the table, oxygenated monoterpenes such as linalool, α-terpineol, trans-pinene hydrate, piperitone, and cuminal are identified. These compounds play a key role in enhancing both intensity and complexity of the aroma. They are also often linked to stronger biological activity compared to hydrocarbon monoterpenes, which may increase the pharmacological potential of the extract. The analysis also reveals presence of several esters derived from cis-3-hexenol, including cis-3-hexenyl isobutyrate, cis-3-hexenyl butyrate, cis-3-hexenyl benzoate, and Z-3-hexenyl tiglate. These compounds are typically responsible for fresh green and fruity notes, contributing to overall aromatic richness of essential oil. At higher retention indices (1350–1650), a significant presence of sesquiterpenes is observed, including β-caryophyllene, α-humulene, germacrene D, valencene, δ-cadinene, α-cadinene, spathulenol, globulol, viridiflorol, and α-cadinol. Although less volatile, these compounds are more stable and contribute to depth and persistence of aroma. Additionally, sesquiterpenes are widely reported to exhibit various biological properties, including anti-inflammatory, antifungal, and cytoprotective activities. Finally, certain compounds such as spathulenol, globulol, viridiflorol, τ-muurolol, and α-cadinol belong to class of oxygenated sesquiterpenes, which are recognized for their significant biological activities, particularly antibacterial, antifungal, and anti-inflammatory effects. The presence of these molecules enhances pharmacological relevance of essential oil, supporting potential valorization of *Anacardium occidentale* in pharmaceutical, food, and cosmetic applications.

Table 8 Composition of essential oil from *Anacardium occidentale* leave [42]

Retention indices	Compounds	Retention indices	Compounds
939	α-Pinene	1455	α-Humulene
979	β-Pinene	1460	Alloaromadendrene
991	Myrcene	1462	Cis-Muurola-4(15) ,5-diene
1003	α-Phellandrene	1477	Trans-cadina-1(6),4-diene
1011	δ-3-Carene	1480	γ-Muurolene
1017	α-Terpinene	1485	α-Amorphene
1025	p-Cymene	1485	Germacrene D
1030	β-Phellandrenerans	1486	Selina-3,5-diene
1050	Trans-β-Ocimene	1491	Ledene
1089	α-Terpinolene	1496	Valencene
1097	Linalool	1500	α-Murolene
-	Trans-4,8-dimethyl-1, 3,7-nonatriene	1508	Eudesma-2,4(15),11-triene
1123	Trans-Pinene hydrate	1506	E,E-α-Farnesene
1147	cis-3-Hexenylisobutyrate	-	Z, E-α-Farnesene
1159	Sabina ketone	1514	γ-Cadinene
1186	Cis-3-Hexenylbutyrate	1523	δ-Cadinene
1189	α-Terpineol	1535	Trans-Cadina-1(2),4-diene
-	Cis-3-Hexenyl-2-methylbutanoate	1539	α-Cadinene
-	Cis-3-Hexenyl-α-methylbutyrate	1546	α-Calacorene
1242	Cuminal	1569	Palustrol
1253	Piperitone	1580	Cis-3-Hexenyl benzoate
1276	Phellandral	1578	Spathulenol
1290	Dihydroedulan II	1585	Globulol
1331	Z-3-Hexenyltiglate	1593	Viridiflorol
1338	δ-Elemene	1599	Rosifoliol
1336	8-Hydroxylinalool	1619	5-Guaiene-11-ol
1351	α-Cubebene	1625	Iso-Spathulenol
-	3,4-Dimethoxyphenol	1633	τ-Muurolol

1375	α-Ylangene	1654	α-Cadinol
1377	α-Copaene		
1384	Hexenyl hexanoate		
1399	Cyperene		
1419	β-Caryophyllene		
1432	β-Copaene		
1441	α-Maaliene		
1447	Aromadendrene		

2.8. Biological activities

Several biological activities of extracts from different organs of *Anacardium occidentale* have been evaluated. Its leaves have demonstrated very interesting antioxidant activity[43];[1];[44];[45];[46]. Likewise, the leaves and stem bark of *Anacardium occidentale* have demonstrated proven anti-inflammatory properties [43];[45];[47];[48];[49];[50]. Other previous studies have also demonstrated the antimicrobial activity of the leaves and bark of this plant [45];[51];[52]. It should also be noted that previous studies have shown that the leaves, trunk bark and root of *Anacardium occidentale* have interesting antidiabetic activity [49];[50];[53];[54]. Anesthetic and insecticidal properties of extracts derivatives from *Anacardium occidentale* have been reported by different authors [51]; [52]. Antiulcerative action of hydroalcoholic extract of *Anacardium occidentale* leaves in an induced experimental colitis model [46]. The plant's anti-inflammatory [55], hypoglycemic [56], antimicrobial [57], antioxidant [58], hypolipidemic [59], and antidiarrheal [60], these properties have been highlighted in other scientific work.

3. Conclusion

Anacardium occidentale plays a significant role in traditional medicine in Africa and worldwide. The different parts of the plant, particularly leaves and stem bark, are widely used for treatment of various ailments such as microbial infections, inflammation, and hypertension. Numerous scientific studies reported in the literature show that this species is rich in secondary metabolites such as tannins, flavonoids, phenolic compounds, saponins, alkaloids, and terpenes, which may explain the diversity of its biological properties. Indeed, several studies have confirmed antimicrobial, anti-inflammatory, antioxidant, antihypertensive and antidiabetic activities of extracts obtained from different parts of the plant, thereby supporting and justifying its use in traditional medicine. However, despite these promising results, further research is still needed to isolate and characterize the bioactive compounds responsible for these activities, to better understand their mechanisms of action, and to evaluate their safety through comprehensive toxicological and clinical studies. Such an approach could promote valorization of this medicinal plant and contribute to the development of new drugs of natural origin. Thus, *Anacardium occidentale* represents a therapeutic resource of great interest whose continued scientific exploration could strengthen integration of traditional knowledge into biomedical research and development of innovative pharmaceutical products.

Declaration of competing interest

Disclosure of conflict of interest

There are no conflicts of interest in connection with this paper, and the material described is not under publication or consideration for publication elsewhere.

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