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# *Combretum micranthum* G. Don – an African miracle of traditional herbal medicine

## Abstract

*Combretum micranthum* G. Don, a species also known as kinkéliba, is a plant widely used in traditional medicine in West Africa. Thanks to its richness of bioactive compounds such as flavonoids, tannins, and alkaloids, it exhibits a broad spectrum of medicinal properties – ranging from anti-inflammatory and antioxidant effects to supporting digestion and regulating blood sugar levels. In folk medicine, it is used to treat among others, fever, malaria, liver disorders, and infections. Due to the growing interest in natural therapies, *C. micranthum* is attracting the attention of researchers as a potential source of new plant-based drugs. This plant represents a fascinating example of the intersection between traditional knowledge and modern phytotherapeutic research.

**Keywords:** chemistry, healing properties, kinkéliba, natural medicine

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## Introduction

Modern medicine is increasingly turning to traditional knowledge, recognizing it not only as a part of cultural heritage but also as a genuine source of therapeutic innovation. Many contemporary pharmaceuticals have their origins in the observation of traditional uses of medicinal plants. One example is white willow bark *Cortex Salicis* (*Salix alba* L.), which has been used for centuries as an analgesic and antipyretic; from it, salicin was isolated – a compound that became the precursor to aspirin (Samuelsson, 2004). Another example is artemisinin, a crucial component of antimalarial drugs, which was isolated from sweet wormwood (*Artemisia annua* L. – *Artemisiae annuae herba*), a plant long used in traditional Chinese medicine (Sudnik-Wójcikowska, 2011; Tu, 2011).

Local herbal medicine plays an important role in complementary and holistic medicine, which is becoming increasingly popular in developed countries. In many cases, medicinal plants are used to support the treatment of chronic illnesses, psychosomatic disorders, or in palliative care (Ernst, 2000). Herbs such as *Melissa officinalis* L., *Valeriana officinalis* L., and *Hypericum perforatum* L. are used in the treatment of anxiety and depressive disorders (Sarris et al., 2011). Although the effectiveness of many of these remedies requires further research, there is growing interest in natural treatment methods, which are often perceived as safer and less invasive (Lee et al., 2025; Schils et al., 2023).

The role of local herbal knowledge in biodiversity conservation and the preservation of cultural heritage is not to be overlooked. This is closely tied to specific natural environments and forms an integral part of the identity of local communities. Its documentation and protection can support both the conservation of endangered plant species and the development of sustainable herbal practices (Cunningham, 1993). Ethnobotany, as an interdisciplinary field of science, plays a particularly important role in this context – studying the relationships between people and plants within cultural, health-related, and ecological frameworks (Casas et al., 2016; Shengji et al., 2020).

Despite its many advantages, local herbal medicine also faces significant challenges. The most important include the lack of standardisation, difficulties in assessing the efficacy and safety of preparations, and the risk of interactions with synthetic drugs (Posadzki et al., 2013). In some countries, such as India and China, traditional medical systems (Ayurveda, TCM, and others) operate alongside conventional medicine, and medicinal plants are officially registered as therapeutic agents (Knöss, Chinou, 2012).

One of the most popular plants in traditional African herbal medicine is undoubtedly *Combretum micranthum* G. Don. This species, which grows wild in the bush (Le Fever, Le Jeune, 1997), has been used for centuries in the folk medicine of West African communities. It was "discovered" for Europe by the French missionary Père Raimbault, which explains its former Latin name *Combretum raimbaultii* Heckel (Govaerts, 1999). Although the plant material was introduced into medicinal use as early as the 19$^{th}$ century, it has never gained such popularity in other parts of the world as in Africa, especially in Senegal (Kerharo, Adam, 1974). Since 1937, *C. micranthum* has been listed in the French Pharmacopoeia (*La Pharmacopée française*), and since 1985, in the African Pharmacopoeia, published by the Organization of African Unity (OAU) (Pousset, 1989).

The aim of this study is to synthesise information on the botanical characteristics and medicinal properties, resulting from the chemical composition, of *C. micranthum*, a medicinal plant little known in Europe but commonly distributed under the name *kinkéliba*.

## Botanical characteristics, distribution, and habitat of *C. micranthum*

*Combretum* is known as bushwillow, whereas *C. micranthum* is commonly called kinkéliba, Health Tree, or Tisane de longue vie (French for "*infusion of long life*"). The name Kinkèlibah is believed to originate from the Niger-Congo Fulani language. This species is also referred to as Sekhew (Sereo) in Wolof and ŋɔlɔbɛ Kobobe in Bambara (Pousset, 1989). In botanical nomenclature, it has numerous synonyms: *Bureava crotonoides* Baill., *Combretum altum* Guill. & Perr. ex DC., *C. floribundum* Engl. & Diels, *C. parviflorum* Rchb., *C. parviflorum* Rchb. ex DC., *C. raimbaulti* Heckel (*POWO*, 2025). The presence of these multiple synonyms indicates that many researchers studied this species simultaneously, each assigning it new names.

*Combretum micranthum* is a shrub or small tree belonging to the family Combretaceae R. Br. It can reach a height of 2 to 5 m, and under favourable conditions, even up to 10 m. It also adopts a climbing habit, wrapping around the branches of nearby trees and producing stems with whitish bark that can grow up to 20 m in length. The tips of its branches are twining. The leaves are shortly petiolate, dark green, broadly oval, pointed at the tips, entire, and leathery (Fig. 1 – Appendix 1). The flowers are tetramerous, small, white or pink, arranged in racemose inflorescences (Fig. 1B). They produce nectar and attract insects, birds, and small mammals (Iwu, 1993). The fruit is a samara (winged nut) with four membranous wings – 1.5 cm long and 1.5 cm wide. It blooms from May to June (Rançon, 1895; Perrey et al., 2004).

The native range of kinkéliba includes northwestern Africa (Iwu, 1993; *African Plant Database*; Fig. 2). According to *POWO* (2025), the species naturally occurs in West Tropical Africa – Benin, Burkina Faso, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone – as well as in West-Central Tropical Africa and the Central African Republic. It has also been introduced into cultivation in the Western Indian Ocean region, including the Comoros and Mauritius.

Kinkéliba is an indicator plant for poor soil (Rançon, 1895; Iwu, 1993), often found on termite mounds, although its roots are not resistant to termites. It grows best in areas where the average daily temperatures range from 22 to 35°C, but may tolerate temperatures between 10 and 45°C. Mature plants may suffer frost damage at –5°C or lower, while new shoots are severely damaged even at temperatures as mild as –1°C.

This plant species prefers an average annual rainfall of 500 to 1300 mm but may tolerate between 300 and 1500 mm. It requires a sunny and warm location. In terms of soil, it grows well on sandstone, clay, laterite, crystalline rocks, and skeletal soils with a pH of 6 to 7, tolerating a range of 5.5 to 7.5. It prefers dry soils and, once established, is very drought-resistant. It relatively withstands forest fires well. The plants propagate

seeds, but to increase germination speed, they must be pre-soaked in water for 24 hours. Removing the seed coat structures may also improve germination rate, which is usually high, reaching up to 100% (*Antropocene.it*, 2023).

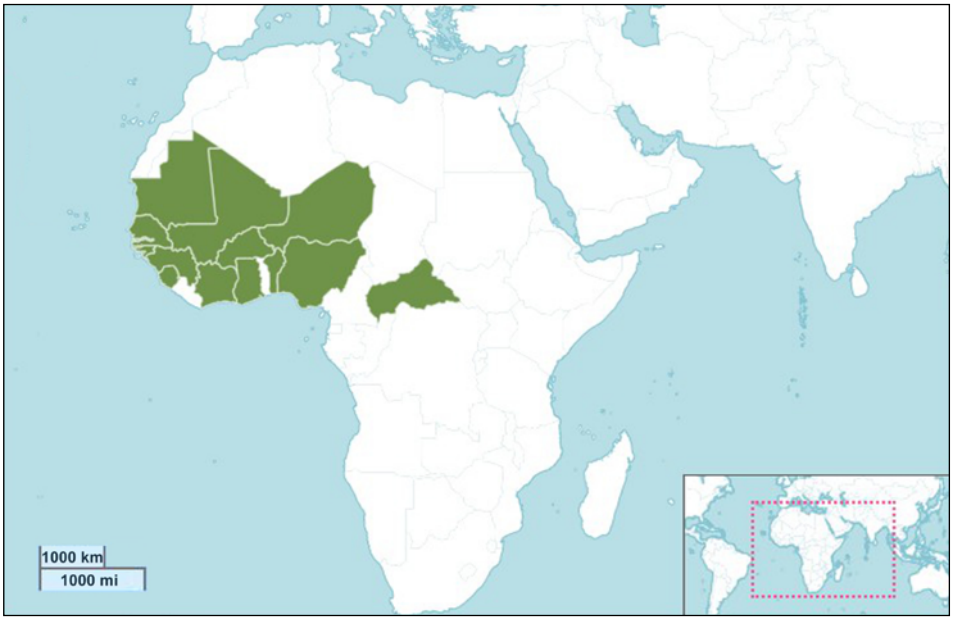


**Fig. 2.** Native range of *Combretum micranthum* G. Don in the world (Source: *POWO*, 2025)

## Medicinal properties of *C. micranthum*

The first samples of kinkéliba were collected by André Rançon (1858–1900), a French doctor and explorer, during a mission in Upper Gambia in 1891. He sent them to his teacher, botanist and pharmacist Édouard Marie Heckel (1843–1916), because, as he claimed, the plant was successfully used to treat bilious fever and haematuria (Ł.W., 1891; Rançon, 1895; Pousset, 1989). The previously mentioned missionary – Père Raimbault, had numerous opportunities to demonstrate the effectiveness of an infusion made from kinkéliba leaves when he and other members of his group experienced attacks of bilious fever, accompanied by or without haematuria. French Navy doctors also used this remedy with good results. According to Heckel (1891), the attention of doctors practicing in the tropics should be directed toward kinkéliba, and its extremely high tannin content should make it a valuable commercial product.

Since then, it has been shown that kinkéliba indeed possesses many other properties that determine its tremendous medicinal potential (Tab. 1).

**Tab. 1.** Main traditional medicinal uses and therapeutic effects of herbal raw materials from *Combretum micranthum* G. Don.

| Herbal raw material | Diseases | Healing effect | Bibliography |
|---|---|---|---|
| *Folium Combreti* | In haemorrhagic yellow fever, liver and biliary tract diseases, viral hepatitis, jaundice, gallstones, as an adjunct treatment in liver cirrhosis and liver tumours, and in hepatomegaly. | Choleretic, cholagogue, antispasmodic, hepatoprotective, anti-inflammatory for the liver. | e.g. Rançon, 1895; Boulet, Huchard, 1914; Adjanohoun, Aké-Assi, 1979; Pousset, 1989; Hodouto, 1990 |
| | For constipation, loss of appetite, anaemia, intestinal colic, vomiting, diarrhoea, and in weight-loss diets; in the treatment of cholera, "Alibain" plague, and typhoid fever. | It stimulates digestive functions, improves metabolism, soothes indigestion, and has antidiarrheal effects. | e.g. Adjanohoun, Aké-Assi, 1979; Le Grand, Wondergem, 1987; Le Grand, 1989; D' Agostino et al., 1990; Astor et al., 1992; Iwu, 1993; Neuwinger, 2000; Abdullahi et al., 2014; Ngene et al., 2015 |
| | For fever, cough, bronchitis, pain, chickenpox and smallpox, ulcers and wounds, as well as malaria. | Anti-inflammatory, analgesic, antipyretic, antiviral and anti-bacterial, antimalarial, and wound disinfectant. | e.g. Tignokpa et al., 1986; Le Grand, Wondergem, 1987; Le Grand, 1989; Neuwinger, 2000; Olajide et al., 2003; Esimone et al., 2005; Udoh et al., 2012; Ngene et al., 2015 |
| | In the prevention and treatment of diabetes, as an adjunct therapy. | Antidiabetic and antihyperglycemic, antihypertensive. | e.g. Malgras, 1992; Baldé et al., 2006; Ngene et al., 2015 |
| | For urinary tract and kidney diseases. | Diuretic, nephro-protective, disinfectant for the ureters and kidneys. | e.g. Le Grand, Wondergem, 1987; Le Grand, 1989; Balansard, Delphaut, 1952a, b; D' Agostino et al., 1990; Malgras, 1992; Iwu, 1993; Neuwinger, 2000 |
| *Radix Combreti* | In the treatment of bruises and sprains, and burns. | Analgesic, anti-inflammatory. | e.g. Kerharo, Adam, 1974; Burkill, 1985; Neuwinger, 2000 |
| *Folium Combreti* | In the treatment of helminth infections, especially those caused by nematodes. | Anthelmintic. | e.g. Neuwinger, 2000; Spiegler et al., 2015 |
| *Semen/Fructus Combretii* | For oral infections and oral candidiasis. | Anti-inflammatory, antifungal. | e.g. Tapsoba, Deschamps, 2006 |

Not all medicinal properties attributed to kinkéliba have been fully validated by scientific research, only by observations originating from Traditional African Medicine. However, due to increased interest, primarily driven by phytochemical analyses, a growing number of studies are now verifying its specific therapeutic uses.

So far, the majority of tests have confirmed the antibacterial and antifungal properties of kinkéliba in *in vitro* studies (Welch, 2010; De Morais Lima et al., 2012; Silén et al., 2023; Tine et al., 2024). For example, Kola et al. (2002) evaluated the antibacterial activity of various extracts (ethanol, n-hexane, chloroform, ethyl acetate, n-butanol, and aqueous fractions) from *C. micranthum* leaves using diffusion and agar dilution methods. The ethanol extract and ethyl acetate fraction showed significantly weaker activity. Whereas the chloroform, n-butanol, and aqueous fractions of leaf extracts exhibited significant activity against bacteria (*Staphylococcus aureus* F.J. Rosenbach, *Pseudomonas aeruginosa* (Schröter) Migula, *Klebsiella pneumoniae* (Schroeter) Trevisan) and fungi (*Candida albicans* (C.P. Robin) Berkhout, *Trichophyton rubrum* (Castell.) Sabour.).

Karou et al. (2005) studied, e.g., the antimicrobial activity of kinkéliba leaves against pathogenic bacteria, aiming to illustrate the relationship between antioxidant capacity and antimicrobial activity. Kinkéliba leaf extracts demonstrated bactericidal effects against *Shigella dysenteriae* K. Shiga, *Salmonella paratyphi*, and *Staphylococcus aureus*, as well as bacteriostatic effects against *Shigella flexneri* Castellani & Chalmers, *S. boydii* Ewing, *Salmonella typhi*, *Klebsiella ozenae* Abdel, and *K. pneumoniae*.

Banfi et al. (2014) also examined *C. micranthum* leaves for the presence of antibacterial compounds. They determined the antibacterial activity against *Escherichia coli* T. Escherich, and methicillin-sensitive *Staphylococcus aureus* MSSA for crude and purified extract fractions. The ethanol extract exhibited the highest antibacterial activity. From the most active crude extracts, a purified fraction was isolated, and its antibacterial efficacy was tested against nine bacterial strains. The results showed that this fraction was effective against both Gram-positive and Gram-negative strains.

Similarly, Martial et al. (2016) confirmed the antibacterial activity of ethanol and ethyl acetate extracts from kinkéliba leaves against 70 *S. aureus* strains isolated from three skin infections (pus, boils, and abscesses) and 10 reference strains (nine bacteria and one yeast). Meanwhile, Boya et al. (2019) described the antibacterial activity of extracts from powdered *C. micranthum* leaves against multidrug-resistant *Vibrio cholerae* Pacini strains that emerged during the epidemic in Benin (West Africa) from 2012 to 2019. Antibiotic-resistant strains were clearly sensitive to kinkéliba extracts.

The source of antibacterial and antifungal active substances turned out to be also the roots of kinkéliba. Taura et al. (2009) studied the antibacterial and antifungal activity of root extracts against *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae* (Klein) Chester, *Salmonella typhi*, *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. The root extracts were obtained using extraction with ethanol,

chloroform, ethyl acetate, and distilled water, and all test organisms were examined using the agar diffusion method. It turned out that they were sensitive to the crude extracts, except for *E. coli* and *C. albicans*. These extracts had a broader spectrum of activity than commercial antibiotics tested against these isolates.

Meanwhile, Udoh et al. (2012) evaluated the antibacterial activity of methanol and aqueous extracts from leaves, bark, roots, and stems against 25 different hospital isolates, including *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis* Hauser, *Pseudomonas aeruginosa*, *Enterococcus faecalis* (Andrewes & Horder) Schleifer & Kilpper-Bälz, *Streptococcus pyogenes* Rosenbach, and *Streptococcus pneumoniae* (Klein) Chester. They used the agar well diffusion method. The obtained extracts showed high antimicrobial efficacy against 200 different clinical isolates, both Gram-positive and Gram-negative.

The strong antibacterial activity of the ethanol extract from the kinkéliba stem bark against *Staphylococcus aureus*, *Bacillus subtilis* (Ehrenberg) Cohn, *Escherichia coli*, and *Pseudomonas aeruginosa* was also confirmed by Akeem et al. (2012).

Already in the 1990s, the antiviral properties of kinkéliba extracts were studied. For example, Ferrea et al. (1993) demonstrated that the *in vitro* antiviral activity of methanol leaf extracts of *C. micranthum* against herpes simplex viruses types 1 and 2 was present only in extracts obtained 7 days before testing, but not in freshly prepared extracts. This result was attributed to the presence of inactive precursors in fresh extracts, which underwent alkaline auto-oxidation to form the active antiviral compound, catechinic acid (CA). However, the species did not show significant antiviral activity against a lentiviral vector in response to its use in the traditional treatment of patients with AIDS (Esimone et al., 2005).

Furthermore, in studies on Tomato brown rugose fruit virus (ToBRFV), a plant virus attacking tomatoes, 4-hydroxybenzoate was isolated from *C. micranthum* leaves as the main product of the extract's auto-oxidation reaction. This compound effectively destroyed the virus *in vitro* and during inoculation on tomato plants. Degradation of the viral genetic material and loss of infectivity were observed, suggesting damage to the virus's protein coat (Iobbi et al., 2022).

Beyond its direct antibacterial effects, the properties of kinkéliba are linked to significant anti-inflammatory activity. Di Carlo et al. (1964) noted that *C. micranthum* had an immunostimulatory effect on the reticuloendothelial system. Meanwhile, Olajide et al. (2003) confirmed the traditional use of kinkéliba leaves in treating inflammation in rats and mice by analysing the effects of methanol extracts from the leaves of this plant. The extract (50, 100 mg/kg) inhibited carrageenan-induced oedema formation in rats. The increased vascular permeability caused by acetic acid injection was also inhibited by the extract at the same dose range. The extract (100 mg/kg) suppressed granuloma formation in rats to a similar extent as indomethacin (5 mg/kg).

Similar studies were conducted by Abdullahi et al. (2014), who demonstrated that the pain-relieving and anti-inflammatory effects of aqueous leaf extracts of *C. micranthum* in mice and rats were comparable to standard drugs used in the studies. Furthermore, Hu et al. (2023) confirmed kinkéliba's ability to reduce UV radiation-induced exposure of pro-inflammatory cytokines IL-6/8 and to alleviate skin inflammation.

Kinkéliba has also been used for a long time in the treatment of protozoal infections. Benoit et al. (1996) confirmed the traditional use of the stems and leaves of *C. micranthum* in treating malaria by inhibiting the *in vitro* growth of *Plasmodium falciparum* Welch strains, both chloroquine-sensitive and resistant, as well as reducing parasitaemia after 30 hours of contact, indicating an effect of the extract on the parasite's reinvasion process. Ancolio et al. (2002) and Karou et al. (2003) noted that kinkéliba leaf extract had moderate antimalarial activity. Namadina et al. (2024) also observed inhibitory effects of crude leaf extract of *C. micranthum* on *P. falciparum* at concentrations of 500, 250, 125, 62.5, and 31.25 mg/ml, with growth inhibition percentages ranging from 88.8% to 66.6%. Interestingly, according to Sore et al. (2025), aqueous extracts of kinkéliba obtained by traditional extraction methods are effective against chloroquine-sensitive CQ 3D7 strains but ineffective against chloroquine-resistant CQ Dd2 strains, and their activity correlates with the content of phenolic compounds.

In traditional African local medicines, *C. micranthum* is also used to treat worm infestations. Ethnoveterinary medicine, prevalent in many regions of Africa, utilises the plant to combat helminths in small ruminants, a common method of treating these animals (Garba et al., 2019). Fidèle et al. (2024) tested extracts from kinkéliba leaves on *Haemonchus contortus* Rudolphi (a parasitic species of small ruminants – goats and sheep). The results showed significant inhibition of larval development and egg hatching, with $IC_{50}$ (half-maximal Inhibitory concentration) values of around 2–3 mg/ml, with larval development inhibition reaching up to 80% for the hydroacetone extract. However, the authors indicated that further *in vitro* studies on the efficacy of these extracts against adult parasites and *in vivo* studies on small ruminants were necessary. Both *in vivo* and *in vitro* studies confirming anthelmintic activity have so far been conducted on the closely related species *C. mucronatum* Schumach. & Thonn. (Spiegler et al., 2015; Belga et al., 2024a,b).

*Combretum micranthum* also exhibits real antidiabetic potential, confirmed both *in vivo* models (rats, mice) and *in vitro*/*in silico* studies (cells, molecular analysis). Tanko et al. (2017) reported that ethanol extract from the leaves significantly lowered glucose levels and improved oxidative stress biomarkers (including MDA, SOD, and catalase) in rats with alloxan-induced diabetes. Meanwhile, Welch et al. (2017) found that polyphenol-rich extracts of kinkéliba reduced PEPCK mRNA expression and decreased glucose production in rat H4IIE hepatoma cells *in vitro*. The compound 2(-)-epicatechin showed the best *in vitro* activity in inhibiting the PEPCK gene and glucose production.

*In vivo* (C57BL/6J mice on a high-fat diet), *C. micranthum* extracts dose-dependently lowered plasma glucose levels without adverse side effects, improving glucose tolerance after seven weeks of the experiment. In the future, besides PEPCK, other crucial factors involved in diabetes development such as phospho-PKA, phospho-CREB, and PGC-1 may also be further studied in this context (Paris, Moyse-Migon, 1956; Bassene et al., 1985; Mashi et al., 2021). Ononamadu and Ibrahim (2021), in *in silico* studies, confirmed that compounds identified in kinkéliba (e.g., 4-hydroxycinnamic acid, glyinflanin A, 3-dehydroxysappanol trimethyl ether) had favourable pharmacokinetic and pharmacodynamic properties regarding α-amylase, α-glucosidase, and the insulin receptor. Molecular modelling showed that compounds such as rutin trihydrate and myricetin-3-rutinoside strongly bonded to α-amylase, the key in carbohydrate metabolism, suggesting potential inhibition of this enzyme (Bodun et al., 2022).

The hypoglycaemic effect of kinkéliba extracts *in vivo* in both normoglycemic and hyperglycaemic rats was confirmed by Chika and Bello (2010). At a dose of 100 mg/kg, the extract exhibited hypoglycaemic activity comparable to that of the standard antidiabetic drug glibenclamide at 0.6 mg/kg. Similar results were observed by Anderson Bel et al. (2024), who noted that at the same dose, kinkéliba reduced glucose levels in transiently hyperglycaemic rats by 57.5% (compared to about 58.8% with glibenclamide). At the same time, Auta and Kumurya (2025) isolated phenolic fractions from the extracts (including chlorogenic acid, gallocatechin, quercetin-7-galactoside) and demonstrated that the quercetin-7-galactoside fraction showed the highest antidiabetic activity, comparable to glibenclamide, with a rapid drop in blood sugar already after 30 min. The results of these studies clearly demonstrated the antidiabetic properties of *C. micranthum* leaf extracts in the treatment of type 1 and type 2 diabetes, fully justifying their traditional use in treating this disease. Some new piperidine flavan alkaloids isolated from the aqueous extract of this plant have already been patented as antidiabetic agents for the treatment of metabolic disorders (Simon et al., 2011).

There are also studies confirming the blood pressure-lowering properties of kinkéliba leaves. For example, Zahoui et al. (2017) demonstrated that at doses ranging from $1.66 \times 10^{-3}$ to $6.10^{-1}$ g/kg body weight, the aqueous extract induced sustained (dose--dependent) hypotension similar to that induced by acetylcholine at doses from $5.6 \times 10^{-7}$ to $5.5 \times 10^{-4}$ g/kg body weight. This extract significantly reduced adrenaline-induced hypertension. Meanwhile, Seck et al. (2017) showed the potential antihypertensive properties of *C. micranthum* leaves in the form of plant powder capsules in adult patients with uncomplicated hypertension (>140/90 mm Hg). The degree of blood pressure reduction was lower than that achieved with ramipril treatment. In 2020, a clinical study demonstrated that *C. micranthum*, administered as tablets or infusions, was as effective as the standard drug captopril in treating hypertension over a 6-month observation period (Bourqui et al., 2021). Significant antihypertensive potential of *C. micranthum*

extract was also confirmed by Kpemissi (2022). The aqueous extract of kinkéliba leaves and its fractions also tend to inhibit ACE (Angiotensin-Converting Enzyme) activity *in vitro*, which may be a mechanism historically utilised in the treatment of hypertension. It has been experimentally confirmed that various extract fractions exhibit antioxidant activity, which may be beneficial in treating hypertension accompanied by free radical generation (Mashi et al., 2021).

Touré et al. (2011) found that kinkéliba exhibited strong scavenging properties against hydroxyl radicals, ABTS radicals, and DPPH radicals. Analyses of lipid peroxidation inhibition, iron chelation, protein oxidation, and reducing power also indicated good antioxidant activity. Yapo et al. (2014) reported that the aqueous extract from the leaves showed high antioxidant capacity, assessed using the DPPH, ABTS, and FRAP assays. Similarly, Niass et al. (2017) used the ABTS method and found an $IC_{50}$ value of 6.727 µg/ml. Tine et al. (2019) evaluated the radical-scavenging properties of leaf extracts of *C. micranthum* collected from three areas during and after the rainy season using the DPPH test. They found that the antioxidant strength was higher after the rainy season. Other experiments have also confirmed the antioxidant properties of kinkéliba leaf extracts (e.g., Ibram, Bashir, 2021; Bashir et al., 2022; Kpemissin et al., 2023).

The leaves of *C. micranthum* have traditionally been used to treat liver and gallbladder ailments. In the Republic of Mali (West Africa), a preparation called HEPATISANE® has long been produced from powdered *C. micranthum* leaves. It is used symptomatically for liver failure, colds, hepatitis, indigestion, and constipation. It is also used as a diuretic. An experiment was conducted in which patients with non-obstructive jaundice were treated with HEPATISANE®, and their bilirubin and transaminase levels returned to normal within 2–3 weeks of starting treatment (Diallo et al., 2005). In turn, in about 50 asymptomatic patients with chronic viral hepatitis B treated with HEPATISANE® in a clinical trial, no elimination of the hepatitis B surface antigen was observed. However, the herbal treatment was well tolerated and no side effects occurred. Further clinical studies are therefore necessary to determine whether this treatment helps patients with symptomatic hepatitis or prevents long-term consequences of chronic viral hepatitis (Haidara et al., 2016). Adebisi and Ugwah-Oguejiofor (2021) investigated the hepatoprotective effects of the aqueous leaf extract in female Sprague-Dawley rats. The aqueous extract of kinkéliba showed hepatoprotective properties against paracetamol-induced hepatotoxicity, demonstrating better preventive effectiveness (before treatment) than therapeutic effectiveness (after treatment).

As early as 2002, it was proven that kinkéliba extracts kill pathogens responsible for diarrhoea (Kola et al., 2002), as previously mentioned. Anafi et al. (2010) conducted studies to verify the antidiarrheal effects of aqueous-methanolic leaf extracts of *C. micranthum*, using castor oil-induced diarrhoea in laboratory animals and preparations

of isolated tissues. They found that the aqueous-methanolic extract, in a concentration-dependent manner (0.8–8 mg/ml), inhibited spontaneous pendular movements of the rabbit jejunum and caused relaxation of the smooth muscles in the guinea pig ileum. In the case of castor oil-induced diarrhoea, the highest doses of 1000 and 2000 mg/kg showed 60% protection, compared to 80% protection from loperamide (5 mg/kg). The results demonstrated that the aqueous methanolic leaf extract of kinkéliba possessed pharmacological activity in the treatment of diarrhoea. Sall et al. (2025a), through survey-based studies, confirmed that regular use of kinkéliba leaves for digestive problems and diarrhoea brought noticeable therapeutic effects.

Concentrated extracts based on *C. micranthum* may also be used in neurological and anxiolytic treatments. Mohammed et al. (2019) investigated *in silico* the effects of methanolic leaf extract of kinkéliba on the GABA receptor. Molecular analysis revealed strong and effective interactions between the GABA receptor and ligands from *C. micranthum*, including 3,5-dichlorophenylhydrazine, guanidine, and aminooxyacetic acid. The results indicated that 3,5-dichlorophenylhydrazine had a binding energy comparable to that of diazepam.

Mohammed et al. (2020) demonstrated that compounds present in the leaf extract of *C. micranthum* had a beneficial effect on modulating and maintaining the integrity of brain cells, which might be of greater importance as a therapeutic agent for preventing or slowing the progression of neurodegenerative diseases.

Kpemissi et al. (2023) assessed anticholinesterase activity using the Ellman method. The kinkéliba extract exhibited a strong anticholinesterase activity ($IC_{50}$ = 59.85–0.91 µg/ml). In an *ex vivo* neuroprotective model, it significantly inhibited oxidative damage induced by $FeCl_2$-AA in brain tissue.

Meanwhile, Amali et al. (2020) evaluated the behavioural effects and anxiolytic potential of kinkéliba in mice. Preliminary results showed that it modulated behavioural paradigms and exhibited a dose-dependent anxiolytic effect.

There is strong scientific evidence (including *in vitro*, *ex vivo*, and *in vivo* studies) confirming the nephroprotective effects of *C. micranthum*, especially in models of diabetic nephropathy and cisplatin-induced nephrotoxicity. Kpemissi et al. (2019a, b) demonstrated that kinkéliba extract exerted renoprotective effects against cisplatin-induced toxicity in both *in vitro* and *in vivo* models developed on HEK-293 cells and rat kidneys.

In 2020, glucose-induced toxicity was studied in human embryonic kidney cells (HEK-293) as an *in vitro* model of diabetic nephropathy. The results showed that exposing cells to high blood glucose concentrations (100 mM) for 72 hours significantly reduced their viability, leading to morphological changes. Treatment with *C. micranthum* extract at concentrations of 10 and 25 µg/ml resulted in a notable improvement in cell viability by 10–23%, compared to the high-glucose control (Kpemissi et al., 2020a).

Although kinkéliba extracts do not show significant toxicity overall, an increase in liver enzyme (ALT, ALP) and changes in urea and glucose levels were observed in a recent subchronic study, which may suggest adaptive metabolic stress or toxicity in sensitive systems (Sall et al., 2025b).

Based on the presented results of numerous studies, it may be concluded that there is growing scientific evidence supporting the multifaceted therapeutic effects of *C. micranthum* extracts. Nevertheless, further in-depth research is still needed, particularly concerning other raw herbal materials derived from this plant.

## Selected aspects of the chemistry of *C. micranthum*

The most commonly used herbal raw material of *Combretum micranthum* is the leaf, known as *Folium Combreti Raimbaultii*. Less frequently used for medicinal purposes are the bark (*Cortex Combreti*), root (*Radix Combreti*), and fruit with seed (*Fructus Combreti*). Among the active constituents, the most frequently mentioned are combretin, catechin, catechin tannins, flavonoids, potassium nitrate, organic acids, coumarins, sterols, terpenoids, carbohydrates, and alkaloids. However, 155 organic compounds have been identified so far in the herbal materials of kinkéliba, including 34 flavonoids, 16 phenolic acids, 14 alkaloids, 15 fatty acids, 14 terpenoids/steroids, 24 amino acids, 8 carbohydrate compounds, and 30 other organic substances (Tab. 2).

**Tab. 2.** Main groups of chemical compounds isolated from the herbal raw materials of *Combretum micranthum* G. Don; the classification into groups according to Tine et al. (2024)

| No. | Name of compounds | Plant material | Authors |
|---|---|---|---|
| 1. | **Flavonoids**<br>baicalin hydrate, (+)-catechin, (+)-catechin-3-O-gallate, cyanidin-3-O-(6”-p-coumaroyl-glucoside), delphinidin-3-O-(6”-p-coumaroyl-glucoside), dihydroquercetin, dihydrodaidzein-7-O-glucuronide, (-)-epicatechin, (-)-epigallocatechin, gallocatechin, 6-geranylnaringenin, homoorientin, hyperoside, isovitexin, leucocyanidin, leucopelargonidin, myricetin, myricetin-3-O-glucoside, myricetin-3-O-rutinoside, naringenin, naringenin-4’-O-glucuronide, orientin, 2”-O-galloylvitexin, 2”-O-galloylisovitexin, 2”-O-galloylorientin, 2”-O-galloylhomoorientin, pelargonidin-3-O-coumarylglucoside, (-)-3’,4’,5’,5,7-pentahydroxyflavan (luteoforol), prodelphinidin trimer, quercitrin, quercetin-3-glucoside, rutin trihydrate, (-)-3’,4’,5,7-tetrahydroxyflavan, vitexin | *Folium*, occasionally *Radix* | Jentzsch et al. (1962); Bassène et al. (1985, 1987); D’Agostino et al. (1990); Touré et al. (2011); Umar et al. (2011); Welch et al. (2017); Kpemissi et al. (2020a); Zeitoun et al. (2020); Daba et al. (2021); Ibrahim, Bashir, (2021); Bashir et al. (2022); Bodun et al. (2022); Zannou et al. (2022) |

| | | | |
|---|---|---|---|
| 2. | **Phenolic acids**<br>benzoic acid, caffeic acid, caftaric acid, chlorogenic acid, p-coumaric acid, p-coumaric acid ethyl ester, dihydrocaffeic acid-3-O-glucuronide, 3,5-dimethoxy-4-hydroxyphenylacetic acid, ferulic acid, furocoumaric acid, gallic acid, gentisic acid, hydroxybenzoic acid, sinapic acid, syringic acid, vanillic acid | *Folium* | Jentzsch et al. (1962); Touré et al. (2011); Kpemissi et al. (2020a); Zeitoun et al. (2020); Ibrahim, Bashir, (2021); Mashi et al. (2021); Bodun et al. (2022); Zannou et al. (2022) |
| 3. | **Alkaloids**<br>betaine, betonicine, choline, desacetylcolchicine, 4-hydroxystachydrine, kinkeloid $A_1$, $A_2$, $B_1$, $B_2$, $C_1$, $C_2$, $D_1$, $D_2$, stachydrine | *Folium* | Paris (1942); Balansard, Delphaut (1946); Paris, Moyse-Migon (1956); Ogan (1972); Bassène et al. (1986a); Welch (2010); Jibril et al. (2022); |
| 4. | **Fatty acids**<br>arachidic acid, eicosapentaenoic acid, elaidic acid, gondoic acid, lignoceric acid, linoleic acid, margaric acid, myristic acid, myristoleic acid, nervonic acid, nonadecanoic acid, oleic acid, palmitic acid, palmitoleic acid, stearic acid | *Folium*, *Semen* | Bassène et al. (1986b); Bony et al. (2014); Bougma et al. (2021) |
| 5. | **Terpenoids**<br>α-amyrin, bartogenic acid-28-β-D-glucoside, betulin, convallasaponin A, cucurbitacin P, $F_2$, epioxylubimin, lupeol, micromeric acid, squalene | *Folium*, occasionally *Radix* | Bassène et al. (1989); Umar et al. (2011); Bony et al. (2014); Zeitoun et al. (2020); Ibrahim, Bashir, (2021); Jibril et al. (2022) |
| 6. | **Steroids**<br>2-deoxy-20-hydroxy-5α-ecdysone 3-acetate, estra-1,3,5(10)trien-17β-ol, 24-nor-5β-cholane-3α,7α,12α, 22,23-pentol, β-sitosterol | *Folium*, occasionally *Radix* | Bassène et al. (1989); Umar et al. (2011); Bony et al. (2014); Mashi et al. (2021); Jibril et al. (2022) |
| 7. | **Amino acids**<br>alanine, 2-amino-hexadecanoic acid, arginine, asparagine, aspartic acid, glutamic acid, glutamine, glycine, histidine, histidylasparagine, homocysteine thiolactone, isoleucine-arginine-isoleucine, isoleucine, leucine, lysine, phenylalanine, proline, serine, threonine, tryptophan-lysine-lysine, tyrosine-serine-arginine, tryptophan, tyrosine, valine | *Semen*, *Folium* | Zeitoun et al. (2020); Bougma et al. (2021); Bashir et al. (2022); Jibril et al. (2022) |
| 8. | **Carbohydrate substances**<br>arabinose, galactose, galacturonic acid, glucose, m-inositol, rhamnose, sorbitol, xylose | *Folium* | Bassène et al. (1981); Yapo et al. (2014) |
| 9. | **Other organic compounds**<br>(aminooxy)-acetic acid, 2-(aminooxy)-ethanamine, atavaquone, C16 sphinganine, C17 sphinganine, citric acid, 3,4-dichlorophenylhydrazine, 3-deshydroxy-sappanol trimethyl ether, di-(2-ethylhexyl) phthalate 2-hydroxy-5-((E)-3-(6-(3,4-dihydroxy-2,5-bis(hydroxymethyl)tetrahydrofuran-2-yl)oxy)-3,4,5-trihydroxyhexoxy-3-oxoprop-1-en-1-yl)benzenesulfonic acid, 2-dimethyl acetic acid, eugenol, | *Folium* | Jentzsch et al. (1962); Bony et al. (2014); Halilu et al. (2016); Ibrahim et al. (2017, 2018); Mohammed et al. (2019); Zeitoun et al. (2020); Mashi et al. (2021); Bashir et al. (2022); Jibril et al. (2022) |

| | | | |
|---|---|---|---|
| | fenarimol, glycolic acid, guanidine, malic acid, megastigmatrienone, N-cyclohexanecarbonylpentadecylamine, nonoxynol-9, oxalic acid, phloionolic acid, propargylamine, sesamol, tartaric acid, 3-tetradecanone, thioridazine, 2,3,4,5-tetrahydroxycyclohexane ester glucoside, 6-O-(3-hydroxy-2-(2-hydroxypropan-2-yl)-7-oxo-2H,3H,7H-furo[3,2-g]chromen-9-yl)oxy-3,4,5-trihydroxyoxane-2-carboxylic acid, α-tocopherol, 12-tricosanol | | |
| 10. | **Minerals**<br>$Ca^{2+}$, $Fe^{2+}$, $Mg^{2+}$, K+, $KNO_3$, $Na^+$, $Zn^{2+}$ | *Semen*, occasionally *Folium* | Paris (1942); Bougma et al. (2021) |

In addition to organic compounds, the minerals of potassium, calcium, magnesium, sodium, iron, and zinc were also identified; all of them are important for health. A detailed summary of the chemical composition, selected chemical structures, and the discovery history of the isolated compounds may be found in the review by Tine et al. (2024).

*In vitro* and *in vivo* studies have shown that the phytochemicals and extracts contained in *C. micranthum* possess a broad range of pharmacological potential, as extensively discussed in the previous chapter. Additionally, kinkéliba extracts appear to be largely safe, as confirmed in acute and subchronic toxicity tests at moderate doses in rodents and other models (Kpemissi et al., 2020b; Ouedraogo et al., 2025). Nevertheless, minor histological changes may occur at very high doses, e.g., in the liver, stomach, or kidneys (Sall et al., 2025b). The risk may also arise from contamination with heavy metals, especially if the plant originates from polluted areas. Other findings have shown that leaves of *C. micranthum* varieties and decoctions made from these leaves contain heavy metals at concentrations lower than the values recommended by the WHO for medicinal plants intended for consumption. Generally, varieties collected from suburban areas contain higher levels of metals than those harvested from forested regions (Diouf et al., 2024). Meanwhile, a fruit fly model suggests that in insect models, extracts may induce metabolic changes at specific doses (a dose of 6 mg/10 g extract increased triglyceride and trehalose levels), but extrapolating these results to humans requires caution (Abubakar et al., 2023). Such studies may provide valuable references for the valorisation of *C. micranthum* in the pharmaceutical industry.

## Commercial distribution and application

Despite its significant medicinal importance, in Europe *Combretum micranthum* is known and used in herbal medicine only in France and Russia (Eloff et al., 2008). In Central European countries such as Poland, Slovakia, and the Czech Republic, kinkéliba is an entirely unknown plant. Its raw material can only be purchased through online stores, as stationary wholesalers and herbal shops do not offer the species (Różański, 2025).

In West Africa, kinkéliba leaves, harvested together with branches, are sold in markets in bundles measuring 50 cm in length, wrapped in palm leaves (Fig. 3A–B – Appendix 1). Only freshly picked green leaves are used, which turn reddish-brown during preservation. The pharmacopeia recommends discarding reddish leaves at harvest, as they are considered significantly less "active" medicinally. Most locals follow this practice as well, preferring to buy green kinkéliba leaves. The leaves are also packed in plastic bags and, in this form, intended for further transport and wide distribution (Fig. 3A – Appendix 1). The distribution of kinkéliba is steadily increasing, especially in Sahel countries – Senegal, Mali, Niger, Burkina Faso, Guinea, and Guinea-Bissau – where its dried leaves are consumed as herbal tea (Silén et al., 2023).

Among Muslims in West Africa, especially the Wolof, Fula, and Mandinka peoples, the leaves, bark, and twigs of kinkéliba are harvested and sold in bundles during the dry season, which precedes and accompanies the month of Ramadan. The plant is used daily to make a strong tea, mixed with sugar and milk, and drunk with bread at sunset as a way to break the fast. Kinkéliba stimulates the appetite, and those who have fasted want to enjoy the richest possible meal during the evening hours from sunset to sunrise. One of the culinary uses is also to apply the leaves of kinkéliba to prepare a refreshing tea known "quinquelibas drink" (Treben, 2017; *Antropocene.it*, 2023). Therefore, kinkéliba tea is consumed daily to aid digestion and improve well-being.

So far, *C. micranthum* does not have a European herbal monograph from the EMA/HMPC (European Medicines Agency), meaning it is not officially registered as a traditional medicinal product in the EU. On the Polish herbal market, a few foreign supplements containing Combretum can be found, e.g., Alta Can Gest capsules (priced from several to a dozen or so dollars per package). Here, kinkéliba is combined with other herbs that have a similar mode of action. It is a valuable but little-known herbal raw material (Różański, 2025).

Typically, for medicinal purposes, decoctions are made from its leaves (*Decoctum Combreti* 5%, 100 ml dosed 2–4 times daily – Fig. 3C–D – Appendix 1) or extracts (*Extractum Combreti fluidum*, 3–5 ml dosed 2–3 times daily). However, no herbal supportive medicines should be used without prior consultation with a doctor, and the above-mentioned doses are taken as examples from an herbal guide.

## Conclusions

*Combretum micranthum* G. Don, due to its exceptionally rich chemical composition abundant in numerous biologically active compounds such as flavonoids, tannins, alkaloids, and saponins, undoubtedly deserves the title of a "herbal medicine miracle." This plant exhibits a wide spectrum of pharmacological activities, including anti-inflammatory, antioxidant, antiviral, antimicrobial, hypoglycemic, hepatoprotective,

and diuretic properties, all confirmed by numerous *in vitro*, *in vivo*, and clinical studies conducted mainly in West African and Asian countries. Despite such an impressive therapeutic potential, kinkéliba remains almost entirely unknown in European herbal medicine and phytotherapy. The lack of widespread presence in pharmacopeias, limited availability of the raw material, and low awareness of its properties mean it is not used on a broader scale outside its traditional areas of application. In the context of growing interest in natural medicine and the search for new, effective, and safe plant-based drugs, *C. micranthum* deserves much greater attention from European researchers, phytotherapists, and the pharmaceutical industry. Further research and wider dissemination of this plant in Western medicine could not only enrich the range of available therapeutic agents but also contribute to the development of more sustainable and holistic approaches to treatment.

**Conflict of interest**

The authors declare no conflict of interest related to this article.

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## Appendix 1


**Fig. 1.** *Combretum micranthum* G. Don: fragment of a branch with flowers and fruits of the "samara" type (A) (Source: https://www.lydiagautier.com/en/products/kinkeliba), leafy branch with small flowers (B) (Source: https://www.ebay.es/itm/166411455348), shape of fruiting shoots (C) (Source: Wikimedia commons)


**Fig. 3.** Dried herbal raw material in the form of traditional bundles or plastic bags intended for distribution and transport (A, B), preparation of a decoction (*Decoctum*) from the leaves of *Combretum micranthum* G. Don (C, D) (Source: Wikimedia commons)

## *Combretum micranthum* G. Don – afrykański cud tradycyjnej medycyny ziołowej

**Streszczenie**

Współczesna medycyna coraz częściej sięga po tradycyjną wiedzę, dostrzegając w niej nie tylko element dziedzictwa kulturowego, ale także cenne źródło innowacji terapeutycznych. Wiele obecnie stosowanych leków wywodzi się z obserwacji tradycyjnego wykorzystania roślin leczniczych. Jedną z ważniejszych roślin w afrykańskim ziołolecznictwie jest *Combretum micranthum* G. Don, znana również jako kinkeliba. Gatunek ten, powszechnie stosowany w medycynie tradycyjnej Afryki Zachodniej, charakteryzuje się bogactwem bioaktywnych związków, takich jak flawonoidy, taniny, alkaloidy, fenole i inne. Dzięki temu wykazuje szerokie spektrum działania – od właściwości przeciwzapalnych i przeciwutleniających, po wspomaganie trawienia i regulację poziomu glukozy we krwi. W lecznictwie ludowym wykorzystuje się ją m.in. w zwalczaniu gorączki, malarii, chorób wątroby, nerek oraz różnych infekcji. W terapiach naturalnymi, *C. micranthum* zyskuje coraz większe znaczenie jako potencjalne źródło nowych leków roślinnych. Stanowi tym samym przykład owocnego połączenia tradycyjnej wiedzy z nowoczesnymi badaniami fitoterapeutycznymi. Niestety, pomimo tak dużego znaczenia leczniczego, w Europie jedynie we Francji i Rosji *C. micranthum* jest gatunkiem znanym i wykorzystywanym w ziołolecznictwie. W innych krajach Europy jest praktycznie gatunkiem nieznanym.

**Słowa kluczowe:** chemia, właściwości lecznicze, kinkéliba, medycyna naturalna

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