International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319 – 6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 4; April 2017; Page No. 3187-3193
DOI: http://dx.doi.org/10.24327/ijcar.2017.3193.0221

Review Article

ETHNOBOTANY, PHYTOCHEMISTRY AND PHARMACOLOGICAL PROFILE OF *VERNONIA GALAMENSIS* (CASS.)LESS: A REVIEW

Jean Noël KEÏTA[1]*., Boubacar Mariko[2]., Donatien KONE[3] and Amidou DOUCOURE[3]

[1]Université de Ségou, Institut Universitaire de Formation Professionnelle (IUFP), Département Sciences et Techniques, BP 24/Tél (223) 21 32 02 30, Mali
[1]Université de Ségou, Faculté d'Agronomie et de Médecine Animale (FAMA), Mali
[3]Université des Sciences, des Techniques et des Technologies de Bamako, Faculté des Sciences et Techniques, Département de chimie BP E 3206 /Tél (223) 20 22 32 44 /fax (223) 20 23 81 68, Mali

A R T I C L E I N F O

Article History:

Received 11th January, 2017
Received in revised form 19th February, 2017
Accepted 22nd March, 2017
Published online 28th April, 2017

Key words:

V. galamensis, ethnobotany, phytochemistry, pharmacological.

A B S T R A C T

Vernonia galamensis is an oilseed plant known for the treatment of diabetes mellitus, chest pain, gastrointestinal diseases, malaria, eye infections, skin infections and as an insecticide. Extracts of *V. galamensis* are known to have sedative, analgesic, larvicidal activity, antidiabetic, insecticidal, anti-ulcer and aqueous extracts of the leaves showed no toxicity. The phytochemical constituents of the leaves, roots, flowers and seeds of *V. galamensis* include flavonoids, coumarins, triterpenes, sterols, sesquiterpene lactones, epoxidized fatty acids and adenosine. This review summarizes the ethnobotanical, pharmacological, phytochemical and toxicity studies of *V. galamensis* (Cass) Less

INTRODUCTION

In the socio-economic context of developing countries, the valorization of medicinal plants can lead to the obtaining of adequate and inexpensive therapeutic responses. Mali has undertaken efforts in this direction by establishing the Department of Traditional Medicine (DMT), which is conducting studies on for the development of improved traditional medicines. The genus *Vernonia* is one of the largest groups in the family *Asteraceae* and includes more than 1000 species distributed widely in tropical and sub-tropical regions of Africa, Asia and America (Jeffrey and Kew, 1988). A total of 109 *Vernonia* species were reported in the literature to have medicinal properties. One hundred and five (105) plants were linked to the treatment or management of 44 human diseases. Plants of the genus also used in ethnoveterinary and zoopharmacognostic practices. A total of 12 *Vernonia* species are reported to be used in ethnoveterinary medicine while 2 species are used in self-medication practices by chimpanzees and gorillas (Toyang et Verpoorte, 2013). The present study, examined the literature on the medicinal properties of *V. galamensis*. It showed that important ethnobotanical, phytochemistry and pharmacology data exist. Traditional healers are using of subspecies and varieties of *V. galamensis* of the treatment of various diseases including diabetes mellitus (Autamashih *et al.*2011), chest pain, gastrointestinal diseases and external wounds (Teklehaymanot and Giday, 2010), malaria (Asres *et al.*2001, Tarwish, 2015), skin infections (Asres *et al.*2001; McClory and Atkinson, 2010). Other studies have shown the interest of *V. galamensis* in sedative (Johri *et al.*1995), analgesic (Johri *et al.*1995), anti-ulcer (Awaad and Grace, 1999; Johri *et al.*1995), larvicidal activity (Tarwish, 2015), antidiabetic (Autamashih *et al.* 2011), insecticide (Favi and Kraemer, 2006) and in the treatment of skin diseases (McClory and Atkinson, 2010). Chemists studied the composition of leaves, flowers, roots and seeds of its sub-species and varieties and isolated an impressive series of molecules including phenolic acids and derivatives (Awaad al.2000), flavonoids (Awaad and Grace,1999; Doucouré *et al.*2010; Miserez *et al.*1996; Keita *et al.* 2016b), coumarins (Awaad al.2000), triterpenes (Perdue *et al.*1993), sterols (Artaud and Iatrides, 1990), glaucolide-type sesquiterpene lactones (Favi *et al.*2008; Perdue *et al.*1993; Zdero *et al.*1990) and fatty acids epoxidized (Fiseha *et al.*2010; Thompson *et al.*1994). The aim of this review is to gather information on traditional therapeutic uses, phytochemistry data and the pharmacological profile of *V. galamensis* (Cass.) Less.

METHODOLOGY

V. galamensis is more known as a plant of commerce for the value of its seed oil than for its medicinal potential (Toyang and Verpoorte, 2013). This work aims to highlight the

Corresponding author:* **Jean Noël KEÏTA
Université de Ségou, Institut Universitaire de Formation Professionnelle (IUFP), Département Sciences et Techniques, BP 24/Tél (223) 21 32 02 30, Mali

phytochemical, chemical and medicinal potential of *V. galamensis*. The current review was achieved using an organized search of the scientific data published on ethnobotany, pharmacology, phytochemistry and acute toxicity of *V. galamensis*. The search was conducted between october 15, 2016 and mars 28, 2017, using the keyword search term *V. galamensis*. The searches were carried out using various databases, including PubMed, Google Scholar (https://scholar.google.com/); Science Direct http://www.sciencedirect.com/, Access to Global Online Research in Agriculture (AGORA) (http://www.fao.org/agora/en/).

Plant Description

Taxonomy According to Gilbert's concept of V. galamensis, this widely distributed species includes six sub-species: afromontana, gibbosa, lushotoensis, mutomoensis, nairobensis, galamensis (Gilbert, 1986). The subspecies V. galamensis Ssp. galamensis M. Gilbert is widely distributed, with 4 botanical varieties: galamensis, petitiana, australis and ethiopica (Burkill, 1985; Gilbert, 1986; Perdue *et al*., 1986).

Geographical distribution

The greatest diversity is found in East Africa, whereas in West Africa only one variety is present: *V. galamensis Ssp. galamensis* Var. *galamensis* M. Gilbert or *V. galamensis* (Cass.) Less or *Centrapalus pauciflora* (Willd.) H. Rob. Or *V. pauciflora* (Willd) (Perdue *et al*., 1986).

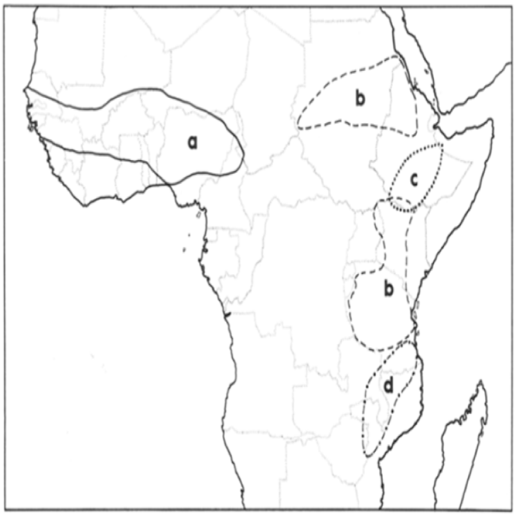

Fig.1 The general distribution of *V. galamensis* Ssp. *galamensis*. a = Var. *galamensis* (West Africa region (Extending from Guinea through Ivory Coast, Mali, Bukino Faso, Ghana to Nigeria) b = Var. *petitiana* (Sudan, Kenya and Tanzania region); c = Var. *ethiopica* (central-southern Ethiopia); d = Var. *australis* (Malawi, Mozambique and eastern Zimbababwe region) (Perdue et al., 1986).

Botanical description

Herbaceous, usually annual, rarely persisting for more than one growing season; warying from small ephemerals 20 cm tall with a single flower head, to robust, rather diffusely branching, somewhat shrubby plants to 5m tall with many flower heads; stems are never branching from the base, they are branching only after the first flower head is formed; the inflorescence consisting of a terminal flower head with lateral flower heads from the uppermost axils, subsequently, if moisture is sufficient for continued growth, the lateral branches of the inflorescences overtopping the first established inflorescence. Leaves alternate, sessile, membraneous, 0.6 -5.0 cm wide, up to 25 cm long, acuminate at the tip, cuneate at the base, margins toothed, surface puberulous to pilose (Gilbert, 1986).

Fig.2 A photograph showing flowers of *V. galamensis* (Cass.)Less.

Ethnobotany

Chest-pain and gastrointestinal diseases In Tanzania and Kenya, the leaves of *V. galamensis* Ssp. *galamensis* Var. *petitiana* are eaten, boiled, or infused to treat chest-pain and gastrointestinal diseases (Baye et Oyen 2007; Burkill, 1985).

Diabetes mellitus

The decoctions of leaves of V. galamensis have been used in folk medicine for ages in the treatment of diabetes mellitus in Tanzania and Nigeria (Autamashih *et al*.2011; Chhabra *et al*. 1989).

Eye infections

The juice of V. galamensis Ssp. nairobensis is applied in the eyes to treat eye infections (Bussmann, 2006).

Larvicidal activity

Larvicidal trials against larvae of the third larval stage of Anopheles gambiae, the most active extract recorded was that of acetone root extract of V. galamensis with an LC50 of 22.85 (Tarwish, 2015).

External injuries, infections and wounds

In Ethiopia, V. galamensis is used to treat external injuries, infections and wounds (Baye and Oyen, 2007; Teklehaymanot and Giday, 2010).

Insecticidal properties

In Senegal, it is used, especially against termites, to protect palisades and timber (Burkill, 1985).

Pharmacology

Some pharmacological interests of the species are given in the following sections:

Sedative Activity

The non-polar fractions of V. galamensis leaves revealed sedative properties at 200 mg/kg in rats (Johri *et al*.1995).

Analgesic activity

Analgesic activity was detected at 200 mg/kg in rats in leaf and seed extracts of V. galamensis (Johri *et al*.1995).

Gastric and duodenal ulcers

Leaf and seed extracts of V. galamensis had antiulcerogenic effects when tested using either hydrochloric acid or ethanol as the necrotising agent in rats (Dahanukar *et al*., 2000; Johri *et al*.1995)

Anti-dermatitis

Epoxidized oil from the seeds of V. galamensis provides topical medicinal preparations that are effective in the prevention and treatment of various forms of skin diseases, skin lesions and wounds (McClory and Atkinson, 2010).

Anti-diabetic

The antidiabetic properties of the aqueous extract of the leaves of V. galamensis were confirmed at a dose of 700mg/kg (Autamashih *et al*.2011). The tablet formulation based on the crude aqueous extract of leaves of V. galamensis, carried out according to the wet granulation method, is now commercially available in Nigeria for the treatment of diabetes mellitus (Autamashih *et al*.2011).

Insecticide activity

The test volatiles from the leaves of V. galamensis is used as an alternative to methyl bromide, a fumigant rescheduled to phase out by 2010 due to its capability to deplete atmospheric ozone. Plant volatiles from leaf extract of V. galamensis were released at room temperature and tested against adult whiteflies and confused flour beetles. One and two hundred microliters of our extract significantly killed adult whiteflies within an hour ($F = 7.86$, $df = 7$, $p = 0.0022$) and continued to be active for twenty hours ($F=10.60$, $df = 5$, $p = 0.0010$). There was significant mortality of confused flour beetles fumigated with 3 mL of plant extract within twenty hours ($F =$ infinity, $df = 4$, $p =$ infinity) whether they were under one gram or ten grams of flour. However, no mortality was observed by the same quantity of plant extract when beetles were under 500 g of flour (Favi and Kraemer, 2006).

Antibacterial activity

A study (Carlos, 2015) of the fixed oil of the seeds isolated unsaturated fats, subsequently converted into aminated fats, vernolamide, tested the antimicrobial activity against the bacteria Escherichia coli, Bacillus subtilis and Saccharoyces aureus, and the fungi Staphylococcus cerevisiae, Microsporum gypseum and Trichophyton mentagrophytes. The authors used the disk diffusion method and the results showed activity against strains of Escherichia and Bacillus subtilis, but not against the yeast and dermatophyte fungi tested.

Membrane stabilizers

The leaf and root extracts of V. galamensis demonstrated prominent in vitro membrane stabilising property as determined by the percentage inhibition of RBC lysis (Johri *et al*. 1995).

Acute toxicity

At an oral dose of 5000 mg/kg in rats, no toxicity or adverse effects were observed for extracts of the leaves form V. galamensis. LD50's greater than 5000 mg/kg body weight are of no practical interest, therefore the crude extract is considered relatively safe (Autamashih *et al*.2011).

Phytochemical screening

Leaves

Phytochemical studies show that the aqueous extract of V. galamensis contains saponins, glycosides, carbohydrates, flavonoids and alkaloids (Autamashih *et al*.2011).

Flowers

As regards, the flowers of V. galamensis Ssp. galamensis Var. galamensis phytochemical screening has shown that they contain flavonoids, tannins, sterols and triterpenes, coumarins, saponosides, reducing compounds, oses and holosides (Doucouré *et al* 2010).

Roots

A phytochemical screening has highlighted the presence of triterpenes, sterols, flavonoids and alkaloids in the roots of V. galamensis Ssp. nairobensis (Mwaura, 1997).

Extracts

Phytochemical screening revealed presence of steroids, saponins, flavonoids, terpenoids and cardiac glycosides in Hexane, chloroformic, ethyl acetate, acetone, methanol and water extracts of leaves and roots of *V. galamensis*. Tannins were present in methanol, water and in acetone extracts of the leaves of *V. galamensis* (Tarwish, 2015).

Phytochemistry

The different classes of compounds isolated from subspecies and varieties of V. galamensis are categorizedas:
Phenolic acids and derivatives

Four (04) molecules of the series of phenolic acids and derivatives were isolated from the alcoholic extract of the leaves of *V. galamensis* Ssp. *galamensis* Var. *Petitiana*: caffeic acid (1), 4-hydroxy-3-methoxy cinnamique acid (2), 3-O-methyl methylgallate (3) et 1-(3, 5- dihydroxyphenyl) propene (4) (Fig.3) (Awaad *et al*.2000).

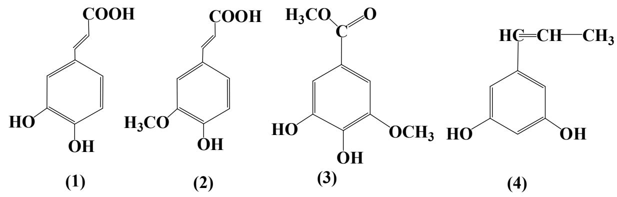

Fig 3 Molecular structures of phenolic acids and derivatives isolated from the leaves of *V. galamensis* Ssp. *galamensis* Var. *Petitiana.*

Flavonoids and Favonoid glycosides

Flavonoids and their glycosides have been reported from many subspecies and varieties of *V. galamensis*.The typical flavonoid aglycones like oriented quercetin and isorhamnetin.The fractionation of the methanolic extract from the leaves of *V. galamensis* Ssp. *nairobensis* allowed to isolate four molecules of the series of flavonols of type 3-O-glycosides: quercetin 3-O-β-D-galactopyranoside (5), quercetin 3-O-β-D-apio-D-furanosyl (1→2) galactopyranoside (6), quercetin 3-O-α-L-rhamnosyl (l→6) galactopyranoside (7) et isorhamnetin 3-O-β-D-apio-D-furanosyl (1→2)-β-D-galactopyranoside (8) (Fig.4) (Miserez *et al*.1996).

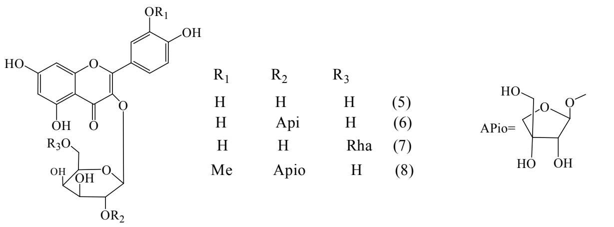

Fig.4 Molecular structures of flavonoids isolated from The leaves of *V. galamensis* Ssp. *nairobensis.*

Six flavonols, including also five 3-O-glycosides, was were detected from the alcoholic extract of the leaves of *V. galamensis* Ssp. *galamensis* Var. *petitiana:* quercetin 3-O-β-D- galactopyranoside (5), isorhamnetin 3-O-β-D-apio-D-furanosyl (1 → 2) β-D- galactopyranoside (8), quercetin (9), quercetin 3-O-β-D-glucoside (10), isorhamnetin 7-O-α-L-rhamnoside (11) and isorhamnetin 3-O-α-L-rhamnosyl (1→6) β-D-glucopyranoside (12)(Fig.5) (Awaad and Grace, 1999).

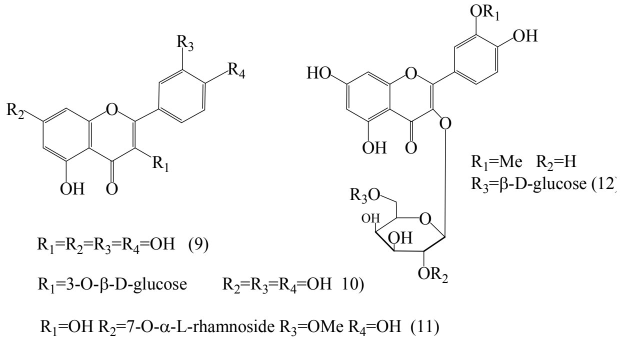

Fig 5 Molecular structures of flavonoids isolated from the leaves of *V. galamensis* Ssp. *nairobensis.*

We report the isolation of 3-O-methylquercetin (13) from the chloroform phase and three monoglycosylated flavonols from the acetate, butanol phases of the hydromethanolic extract of the flowers of V. galamensis Ssp. galamensis Var. galamensis: kaempferol-3-O-α- rhamnoside (14), quercetin 3-O-rhamnoside (15) and 3-O-methylquercetin 4′-O-β-D-glucoside (16) (Fig.6) (Doucouré *et al*.2010; Keita *et al*.2016a).

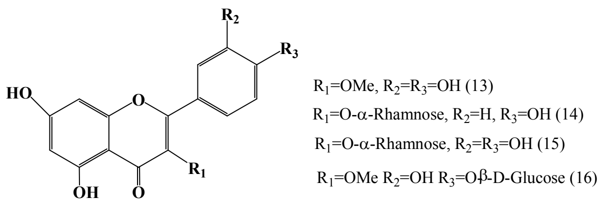

Fig 6 Molecular structures of flavonoids isolated from the flowers of V. galamensis Ssp. galamensis Var. galamensis.

Coumarins

Of the variety V. galamensis Ssp. galamensis Var. Petitiana, coumarins scopoletin (17) and ombelliferone (18) widely distributed in higher plants, have been isolated (Fig. 7) (Awaad *et al*.2000).

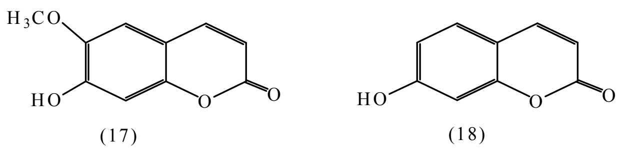

Fig 7 Molecular structures of coumarins isolated from *V. galamensis* Ssp. *galamensis* Var. *petitiana*.

Sesquiterpene lactones

The chemical investigation of the MeOH/Et_2O/petroleum ether (1: 1: 1) extract of the aerial parts of two varieties of *V. galamensis*: *V. galamensis Ssp. galamensis* Var. *Petitiana*; *V. galamensis Ssp. galamensis Var. ethiopic*a and two subspecies: *V. galamensis* Ssp. *gibbosa*; *V. galamensis* Ssp. *afromontana* identified six compounds consisting of five sesquiterpene lactones of type and benzyl senecioate: prevernocistifolide-8-O-senecioate (19), 14-O-Prevernocistifolide-8-O-senecioate (20), 2α,3α-epoxyprevernocistifolide-8-O-senecioate (21), 14-O-prevernocistifolide-8-O-isobutyrate (22), prevernocistifolide-8-O-isobutyrate (23) and benzyl senecioate (24) (Perdue *et al*.1993), from *V. galamensis* Ssp. *galamensis* Va*r. ethiopica*; the prevernocistifolide-8-O-isobutyrate (23) (Fig.8) was isolated (Favi *et al*.2008).

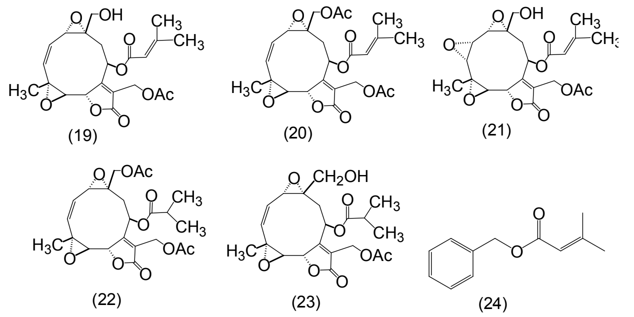

Fig.8 Molecular structures of sesquiterpene lactones and benzyl senecioate (24) isolated from Var. *petitiana* et Var. *petitiana*) and (Ssp. *gibbosa* and Ssp. *afromontana*) of *V. galamensis*.

Treatment of the (Et2O / MeOH (9: 1) of the extract MeOH / Et2O / Petroleum ether (1: 1: 1) of the aerial parts of V. galamensis Ssp. nairobensis gave two new glaucolides: glaucogalamensolide isovalerate (25) and glaucogalamensolide isobutyrate (26) (Fig.9) (Zdero *et al*.1990).

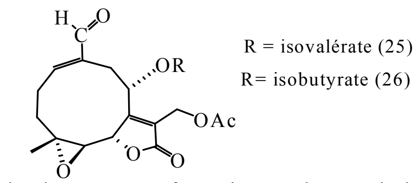

Fig 9 Molecular structures of sesquiterpene lactones isolated from *V. galamensis* Ssp. *nairobensis*.

Triterpenes and sterols

Four triterpenes including: taraxasteryl acetate (27), taraxasterol (28), friedelane (29), friedelan-3 β-ol (30) (Fig.9), and two sterols: β-sitosterol (31) and stigmast-5,22-dien-3-ol (32) were isolated and identified hexane extract (Fig.10) (Mwaura, 1997).

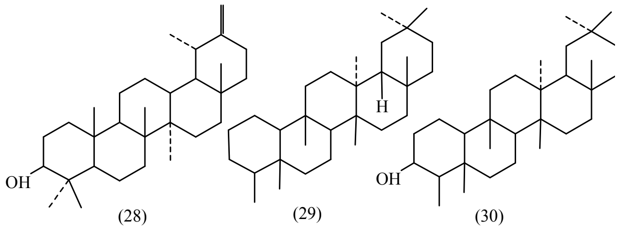

Fig 10 Molecular structures of triterpenes and sterols isolated from the roots of *V. galamensis* ssp. *nairobensis.*

The presence of triterpenes and sterols were demonstrated by GC / MS identification in the leaves, roots and aerial parts of two varieties of V. galamensis: V. galamensis Ssp. galamensis Var. petitiana (α-amyrin (32), α-amyrin acetate (33), β-amyrin (34), β-amyrin acetate (35), caryophyllene (36), lupeol acetate (37), lupeyl (39), cyperene (40) and V. galamensis Ssp. galamensis Var. ethiopica (α-amyrin (32), α-amyrin acetate (33), β-amyrin acetate (35), caryophyllene (36), taraxasteryl acetate (27), lupeyl acetate (39), β-sitosterol (31), stigmasterol (40).

The following compounds were identified as two sub-species: V. galamensis Ssp. gibbosa (α-amyrin (32), β-amyrin (34), α-amyrin acetate (33), β-amyrin acetate (35), taraxasteryl acetate (27), lupeol, lupeyl acetate (37), β-sitosterol (31) and stigmasterol (41) and V. galamensis Ssp. afromontana (α-amyrin acetate (33), β-amyrin acetate (35), taraxasteryl acetate (27), α-humulene (38), lupeyl acetate (39), β-sitosterol (31), stigmasterol (41) (Fig.11) (Perdue *et al*., 1993).

Three pentacyclic triterpenes (β-amyrin acetate (35), 3-oxo-urs-12-en-24-oic acid methyl ester (52) and 3β- (acetyloxy) ursan- 12-one) (53) (Fig.11) were identified by GC / MS in electron impact (EI) and positive chemical ionization (PICI) of the petroleum ether phase of the hydromethanolic extract of the flowers of V. galamensis Ssp. galamensis Var. galamensis) (Keita *et al*. 2014).

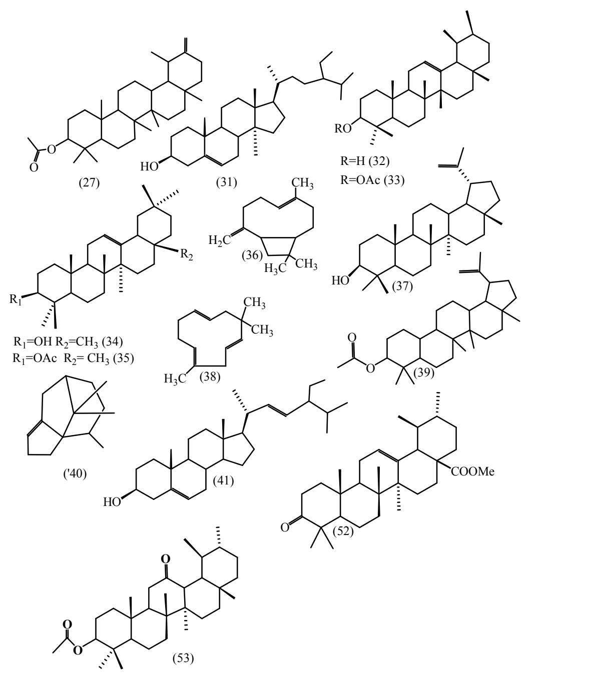

Fig 11 Molecular structures of triterpenes and sterols identified of V. galamensis Ssp. galamensis (Var. petitiana, Var. galamensis and Var. ethiopica) and (Ssp. gibbosa and Ssp. afromontana).

The CG / MS sterol composition of the seed oil of *V. galamensis* Var. *Australis* from Zimbabwe is cholesta-5-en-3β-ol (42), 24-methyl cholesta-5-en-3β-ol (43), 24-ethyl cholesta-5,22-dien-β3-ol (44), 24-ethyl cholesta-5-en-β-ol (45), 24-ethylidene cholesta-5-en-3β-ol (46), 24-ethyl cholesta-7-en-β3-ol (47), 24-ethylidene cholesta-7-en-β-ol (48). The most predominant were 24-ethyl cholesta-5-en-3β-ol (36.9%) (49), cholesta-7-en-3β-ol 24-ethyl (25.2%) (50) and 24-ethyl cholesta-5,22 -diene-3β-ol (18.5%) (51) (Artaud and Iatrides, 1990).

Nucleoside

The phytochemical study of the butanol phase of the hydromethanolic extract from the flowers of *V. galamensis* Ssp. *galamensis* Var. *galamensis* allowed the isolation and identification of 9-β-D-ribofuranosyl-6-aminopurine (54) (Fig.12) (Keita *et al*. 2016b) The seeds of *V. galamensis* (Cass.) Less contain 40% epoxy oil (trivernolin) (55) (Fig.13), which, when hydrolyzed, yields different fatty acids with a very high content (80%) of vernolic acid (cis-12,13-epoxy-cis-9-octadecenoic acid) (56) (Fig.14) (Fiseha *et al*., 2010). Within the four varieties of Ssp. *galamensis,* in which most of the current domestication effort is centered on, oil contents ranged from 31.8% to 38.4%, and 18: 1 epoxy fatty acid ranged from 68.0% to 77.0%. Mean levels of other fatty acids within the species were about 14% for linoleic acid (18: 2) (57), 7% for oleic acid (18: 1) (58), and from 2 to 3% for both palmitic acid (16: 0) (59) and stearic acid (18: 0) (60) (Fig.13) (Thompson *et al*.1994).

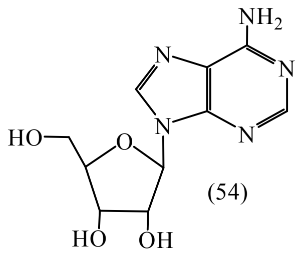

Fig 12 Molecular structure of adenosine isolated from flowers of *V. galamensis* Ssp. *galamensis* Var. *galamensis.*

Fatty acids and derivatives

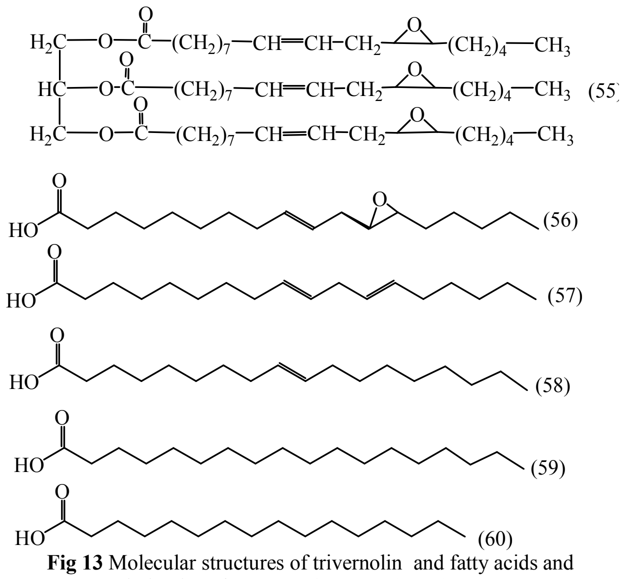

Fig 13 Molecular structures of trivernolin and fatty acids and derivatives from *V. galamensis* (Cass.) Less.

On the other hand chemical investigation of the seeds of *V. galamensis* found two compounds, which are vernolic acid derivatives. Successive fractionation of 30 g of thick oil of the CH_2Cl_2 extract and 25 g of MeOH extract of the seed by flash chromatography resulted in the isolation and characterization of two vernolic acid derivatives, *cis*-(12*S*,13*R*)-(3-methylpentyl) vernolate (61) and *cis*-(12*S*,13*R*)-(2,3-propanediol) vernolate (62) (Fig.14) (Fiseha *et al*.2010).

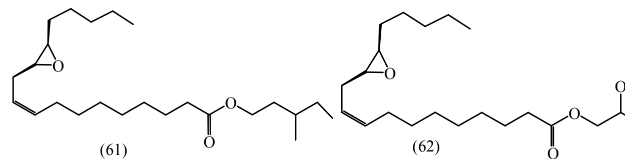

Fig 14 Molecular structures of vernolic acid derivatives isolated from the seeds of *V. galamensis.*

DISCUSSIONS

This review certifies the richness as well as the structural diversity in secondary metabolites of the sub-species and varieties of *Vernonia galamensis*. It highlights the role of the species in the prevention and treatment of various pathologies in traditional medicine. Data from the literature on the chemical composition of the leaves, roots, flowers and seeds of sub-species and varieties of *V. galamensis* indicate a wide variety of secondary metabolites including sesquiterpene lactones, coumarins, phenolic acids, flavonoids, triterpenes, sterols and fatty acids with natural epoxidation and their derivatives. This work constitutes a valuable source of information for the African medicinal flora. It could be a database for further research in the fields of phytochemistry and pharmacology and for the purpose of seeking new natural substances.

CONCLUSION

This review constitutes a source of information which contributes to knowledge of the African medicinal flora and to a safeguard of the local popular knowledge. The approach used clearly identified all uses of *V. galamensis*. It may also constitute a database for the valorization of the species *V. galamensis* in order to discover active principles which can be used in pharmacology.

References

Artaud, J., Iatrides, M. C.(1990). Sterol composition of *Vernonia galamensis* seeds. *Journal of Fitoterapia* 61, 4: 378.

Asres, K., Bucar F., Kartnig T., Witvrouw M., PannecouqueC.andClercq E. De. (2001). Antiviral Activity Against Human Immunodeficiency Virus Type 1 (HIV-1) and Type 2 (HIV-2) of Ethnobotanically Selected Ethiopian Medicinal Plants. *Phytother. Res.* 15, 62–69

Autamashih, M., Isah, A. B., Allagh, T.S., Ibrahim, M. A. (2011). Critical Diluent- Binder Choice in the Tablet Formulation of the Deliquescent Crude Leaves Extract of *V. galamensis* (Asteraceae). *Inter national Journal of Pharmaceutical Research and Innovation* 3: 7-13.

Awaad, A.S. and Grace, M.H. (1999). Flavonoids and pharmacological activity of Vernonia galamensis ssp. galamensis var. petitiana, *Egyptian Journal of Pharmaceutical Sci ences 40, 2: 117-128.*

Awaad, A.S., Sokkar, M.b., Khafaga H.A. (2000). Pharmacognostical studies and biological activity for *V. galamensis sub-speciesgalamensis var. petitiana* (A. rich) M. Gilbert. Bull. Fac. Pharm. Cairo Univ. 38, 3: 107-113.

Carlos, A., Sobrinho, N., Bezerra de S.E. and Oliveira dos, R.S.F.(2015).A review on antimicrobial potential of species of the genus *Vernonia* (Asteraceae). *Journal of Medicinal Plants Research.* Vol. 9(31), pp. 838-850.

Baye, T. M., & Oyen, L.P.A. (2007). *Vernonia galamensis* (Cass.) Less. [Internet] Fiche de PROTA4U. van der Vossen, H.A.M. & Mkamilo, G.S. (Editeurs). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wage ningen, Pays Bas. <http://www.prota4u.org/search.asp>.Visité le 28 janvier 2014.

Baye, T. and Gudeta, S. Pest Survey of *Vernonia galamensis* in Ethiopia.(2002).Trends in new crops and new uses.Industrial Oilseeds J. Janick219-221.

Burkill, H.M. (1985). The useful plants of West Tropical Africa. 2nd Edition., Royal Botanic Gardens, Kew (K).

Bussmann, R.W. (2006). Ethnobotany of the Samburu of Mt. Nyiru, South Turkana, Kenya. *Journal of Ethnobiology and Ethnomedicine*, 2,35: 20.

Chhabra, S.C., Mahunnah, R.L.A., Mshiu, E.N.(1989). Plants used in traditional medicine in Eastern Tanzania.II angiosperms (Capparidaceae-Ebenaceae). *Journal of Ethnopharmacology* 25:339-359.

Dahanukar, S.A. Kulkarni, R.A. Rege, N.N. (2000). pharmacology of medicinal plants and natural products. *Indian Journal of Pharmacology* 32: S81-S118.

Dierig, D.A. and Thompson, A.E. (1993). *Vernonia* and *Lesquerella* potential for commercialization In: J. Janick and J.E. Simon (eds.), new crops. Wiley, New York 362-367.

Doucouré A, Garcia J, Koné D, Aliou AK, et Keïta JN. 2010. Isolement de la 3-O- méthylquercétine des fleurs de *Vernonia galamensis* (Cass.) *Less. J. Soc*. Ouest-Afr. Chim., 030: 93-102.

Favi, F., Charles, L.C., Tadesse M., and Mark E. K.(2008). Leaf peltate glandular trichomes of *V. galamensis ssp. galamensis* var. *ethiopica* Gilbert: Development, structure and chemical composition, *Int. J. Plant Sd*. 169, 5:605-614.

Favi F., Kraemer, M. (2006). Agricultural Research: Using Volatiles from the Leaves of *V. galamensis* to control insect pests. Abstracts of papers, 84th Annual Meeting of the Virginia Academy of Science.

Fiseha, A., Tadesse, M., Bekele, T. et Bedemo, B. (2010). Phytochemical investigations of *V. galamensis* seeds. Chemistry of Natural Compounds 46, 5: 692-695.

Gilbert, M.G. (1986). Notes on east African *Vernonieae* (Compositae). A revision of the *V. galamensis* complex. Kew Bul. 41,1:19-35.

Johri, RK, Singh, C, Kaul, BL. (1995).*Vernonia lasiopus* and *V. galamensis*: a medi cinal perspective. Research and Indus try 40:327–328.

Jeffrey, C and Kew., B. (1988). *The Vernonia in East Africa; Notes on the Composite*, 43, 195 pp.

Keïta, J.N, Koné, D., Doucouré, A. et Garcia, J. (2014).Etude phytochimique de la phase d'éther de pétrole de l'extrait hydrométhanolique des fleurs de *Vernonia galamensis* Ssp. *galamensis* Var. *galamensis* M. Gilbert.8ème Symposium Malien sur les Sciences Appliquées (MSAS), Acte de la conférence.161-166. *http://www.msas.maliwatch.org/msas2014*.

Keïta, JN., Koné, D., Tounkara H., Doucouré A and Garcia J. (2016).Isolation and identification of three mono-glycosylated flavonoids from flowers of V. galamensis Ssp. gala mensis Var. galamensis M. Gilbert. Maghr. J. Pure &Appl. Sci., 2 (2)39- 46.

Keïta, JN., Koné, D., Abdoul, AK., Doucouré, A and Garcia J. (2016). Isolement et identification de la 9-β-D-ribofuranosyl-6-aminopu rine des fleurs de V. galamensis Ssp. galamensis Var. galamensis M. Gilbert. Afrique SCIENCE 12(4) 366 – 373.

Miserez, F., Potterat O., Marston A., Mungai G.M., Hostettmann, K. (1996).Flavonol glycosides from*V. galamensis ssp. Nairo biensis*; phytochemistry 43, 1: 283-286.

McClory, P.G, Atkinson, A. (2010). Use of Naturally Occurring Epoxidised Molecules from *V. galamensis*. US Patent no, US7803409 B2.

Mbugua, M.N, Yusuf, A.O. Gitu, P.M. and B.M. Bhatt. (2007). conversion of vernonia galamensis oil to pyridinylvernolamides and their antimicrobial activities, *Bull. Chem. Soc. Ethiop.* 21(1), 103-110.

Mwaura, J. K. (1997). Investigation of the major chemical components in the roots of *V. galamensis* ssp. *Nairobensis*. De gree of Masters of Science, Univer sitéde Nairobi.

Ncube, I., Read, J.S., Adlercreutz, P. andMattiasson, B. (1998).Triacylglycerols of *V. galamensis* seed oil. Phytochemistry 47,5 : 723-724.

Perdue, R. E., Tsichritzis, F. and Jakupovic, J.(1993). Prevernocistifolide from *Vernonia galamensis* Phytochemistry 34, 4: 1075- 1077.

Perdue, R.E., Carlson, K.D. and Gilbert, M.G. (1986). *V. galamensis* potential new crop source of epoxy acid. *Econ. Bot* 40: 54-68.

Shimelis, H., Gwata, E.T. (2013). Evaluation of the Agronomic Performance of *Vernon ia* (*V. galamensis*) Germplasm. *Agri cultural and Biological Sciences* 10.5772/55016.

Tarwish, B. (2015). Larvicidal activity and phytochemical composition of crude extracts derived from *Vernonia lasiopus*, *Vernonia auriculifera*and *V. galamensis* against the malaria vector *Anopheles gambiae*. Thesis Biotechnology, Kenyatta Uni versity, p 34, 50-56.

Teklehaymanot, T., Giday, M. (2010). Quantitative ethnobotany of medicinal plants used by Kara and Kwego semi-pastoralist people in lower Omo River Valley, Debub Omo Zone, Southern Nations, Nationalities and Peoples Regional State, *Ethiopia. Journal of Ethnopharmacology* 130: 76-84.

Toyang, N.J, et Verpoorte, R. (2013). A review of the medicinal potentials of plants of the genus *Vernonia* (Asteraceae). *Journal of Ethnopharmacology* 146, 3: 681-723.

Thompson A.E., Dierig D.A., Kleiman R. (1994). Characterization of *V. galamensis* germplasm for seed oil content, fatty acid composition, seed weight, and chromosome number. *Industrial Crops and Products* 2, 4: 299-305.

Zdero, C., Bohlmann, F., Mungai, G.M.(1990). A glaucolide type sesquiterpene lactone from *V. galamensis Ssp. nairobensis*. Phyto chemestry29, 11 : 3668-3669.

How to cite this article:

Jean Noël KEÏTA *et al* (2017) ' Ethnobotany, phytochemistry and pharmacological profile of vernonia galamensis (cass.)Less: a review', *International Journal of Current Advanced Research,* 06(04), pp. 3187-3193.
DOI: http://dx.doi.org/10.24327/ijcar.2017.3193.0221

****