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A new flavonoid glycoside from *Tapinanthus* sp. (Loranthaceae) and evaluation of anticancer activity of extract and some isolated compounds

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ABSTRACT

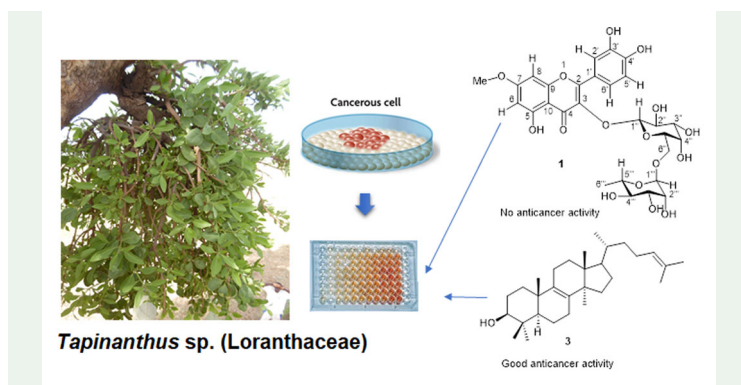
The present work describes the isolation and anticancer activity of *Tapinanthus* sp. which is a hemi parasitic plant harvested on *Combretum glutinosum*, the host plant. Phytochemical study afforded a new flavonoid glycoside, tapinantoside (**1**) isolated for the first time from natural source, alongside six known compounds (**2-7**). Structure of compounds were elucidated by extensive spectroscopic analyses including 1D and 2D NMR, mass spectrometry and by comparison with literature data. The anticancer activity of extract and some isolated compounds were evaluated on glioblastoma (U87MG, C6) and prostate (PC-3) cancer cells. The methanol leaves extract showed good anticancer activity against U87 ($IC_{50} = 21.40 \mu\text{g/mL}$) and PC-3 cells ($IC_{50} = 10.26 \mu\text{g/mL}$). Compound **3** powerfully inhibits the proliferation of C6 ($IC_{50} = 38.84 \mu\text{M}$) and PC-3 cells ($IC_{50} = 21.33 \mu\text{M}$), while its effect was moderated on U87MG cells. Compound **1** and **7** were not active on all tested cancer cell lines.

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1. Introduction

Throughout history medicinal plants have played important role in the treatment of various ailments including cancer. This latter is one of the leading cause of dead worldwide and is characterised by an abnormal and uncontrolled cell growth. The global cancer burden is estimated to have risen to 19.3 million new cases and 10.0 million deaths in 2020 (IARC). Despite considerable efforts, cancer still remains an aggressive killer in the world. Chemotherapy is one of the modern approaches to treat cancer using various groups of drugs. But this method still has problems in terms of toxicity and selectivity which cause adverse side effects on normal cells/tissue such as nausea, vomiting, alopecia and bone marrow function inhibition (Sak, 2012; Baskar et al. 2014). Chemotherapy is also associated with the problem of resistance of cancer cells to the conventional anticancer drugs making ineffective the treatment. Regarding all these problems, it becomes urgent to search for new anticancer agents. Plants are an important source of bioactive compounds that can show new mechanism of action and have a weak toxicological effect. *Tapinanthus* sp. is a plant species belonging to the Loranthaceae family which comprises more than 76 genera and about 1000 species (Nickrent et al. 2010). In Cameroon, the Loranthaceae family comprises 7 genera distributed in 26 species (Balle, 1986). *Tapinanthus* sp. is an unlisted plant species from the collection of plants listed at the National Herbarium of Cameroon (NHC), but the host plant have been identified as *Combretum glutinosum* (Combretaceae). *Tapinanthus* sp. was selected through an ethnobotanical survey. It's a hemi parasitic plant which grows on certain plants host, particularly on *Combretum glutinosum* (Combretaceae). Only *Tapinanthus* sp. growing on *C. glutinosum* is used by traditional healers in northern Cameroon to treat cold, intern wound and cancer. Previous phytochemical studies on *Tapinanthus* genus have revealed the presence of a variety of secondary metabolites including triterpenoids, saponins, flavonoids and phenolic compounds (Patrick-Iwuanyanwu et al. 2014; Maza et al. 2017). Pharmacological studies of *Tapinanthus* species demonstrated their antimicrobial activity (Maza et al. 2017); antioxidant activity (Vougat et al. 2015), antidiabetic activity (Tarfa et al. 2012); analgesic and anti-inflammatory activity (Nwafuru et al. 2017), antiplasmodial activity (Abdullahi et al. 2015) and anticancer activity (Oriola et al. 2018). This latter is fewly reported in the literature. The present work describes the isolation, structure

elucidation through spectroscopic analysis and anticancer activity of the methanol extract and some isolated compounds from the leaves of *Tapinanthus sp.* This is the first report of this plant species.

2. Results and discussion

2.1. Phytochemical results

Air-dried powder of the leaves of *Tapinanthus sp.* was extracted with methanol to afford 26 g of methanol crude extract. Column chromatography separation of the extract resulted in the isolation of one new compound tapinantoside (**1**, 95 mg) and six known compounds, a mixture of β -sitosterol (**2a**) and stigmasterol (**2b**), euphol (**3**, 46 mg), β -amyirin (**4**, 264 mg), ursolic acid (**5**, 122 mg), oleanolic acid (**6**, 82 mg) and 3 β -*O*-*D*-glucopyranosyl- β -sitostérol (**7**, 42 mg) or daucosterol [Figure 1](#).

Compound **1** was isolated as a yellow powder. Its m.p. is 169.8 – 170.8 °C. The molecular formula of compound **1** C₂₈H₃₂O₁₆ was determined from its HR-ESI-MS mass spectrum ([Figure 1S](#)) which showed in positive mode the pseudomolecular ion peak [M + H]⁺ at m/z 625.1745 (calcd. 625.1690) accounting for thirteen degrees of unsaturation. The NMR data of compound **1** presents similarities with those of rhamnetin (Olennikov and Chirikova [2018](#)) and isorhamnetin-3-*O*-robinobioside (Buschi and Pomilio [1982](#)), and its structure have been established from these later. The ¹H NMR spectrum ([Figure 2S](#)) of compound **1** shows in low-field region signals of aromatics protons at δ_H 7.72 (1H, d, J = 2.0 Hz); 7.68 (1H, dd, J = 8.6; 2.0 Hz) and 6.91 (1H, d, J = 8.6 Hz) characteristic of ring B of flavonoids skeleton (Mabry et al. [1964](#); Awouafack et al. [2017](#)) attributable to protons H-2', H-6' and H-5', respectively. Coupling constant between these protons suggest that the ring B is *ortho* disubstituted. In addition, other aromatic protons signals appear at δ_H 6.62 (1H, d, J = 2.0 Hz) and 6.37 (1H, d, J = 2.0 Hz) are characteristics of ring A of flavonoids (Mabry et al. [1964](#); Awouafack et al. [2017](#)) assignable to protons H-8 and H-6, respectively. The weak coupling constant (J = 2.0 Hz) between H-8 and H-6 proton suggest that the ring A is *meta* disubstituted. The spectrum also displayed a signal of methoxy group as a singlet at δ_H 3.91 (3H, s), as well as two anomeric protons as doublets at δ_H 5.18 (1H, d, J = 7.7 Hz) and 4.55 (1H, d, J = 1.73 Hz). The coupling constant J = 7.7 Hz of the anomeric proton at δ_H 5.18 indicate a diaxial coupling which suggest a β -configuration of the sugar moiety while the coupling constant J = 1.73 Hz of the anomeric proton at δ_H 4.55 indicate a diequatorial coupling which suggest an α -configuration of the sugar moiety on the aglycone. The presence of sugars is confirmed by the signals of osidic protons in the range of δ_H 3.84–3.29 ppm. The chemical shift at δ_H 1.14 (3H, d, J = 6.1 Hz) attributable to a methyl group and the anomeric proton at δ_H 4.55 ppm indicate that rhamnose is one of the sugars. The sugar units have been identified as galactose and rhamnose compared with literature data and its correspond to the disaccharide robinobioside (Buschi and Pomilio [1982](#)). The aglycone moiety of **1** is identified as rhamnetin from the previously reported data (Olennikov and Chirikova [2018](#)). The ¹³C NMR spectrum ([Figure 3S](#)) combined with HSQC and DEPT spectra showed resonances for 28 carbons including one methyl group, one oxymethylene, five methines, ten oxymethines, one methoxy group and ten quaternary carbons. The signal at δ_C 179.5 was assigned to a carboxyl carbon of flavonoids (C-4), while signals at δ_C 104.5 and 102.4 are anomeric carbons, respectively

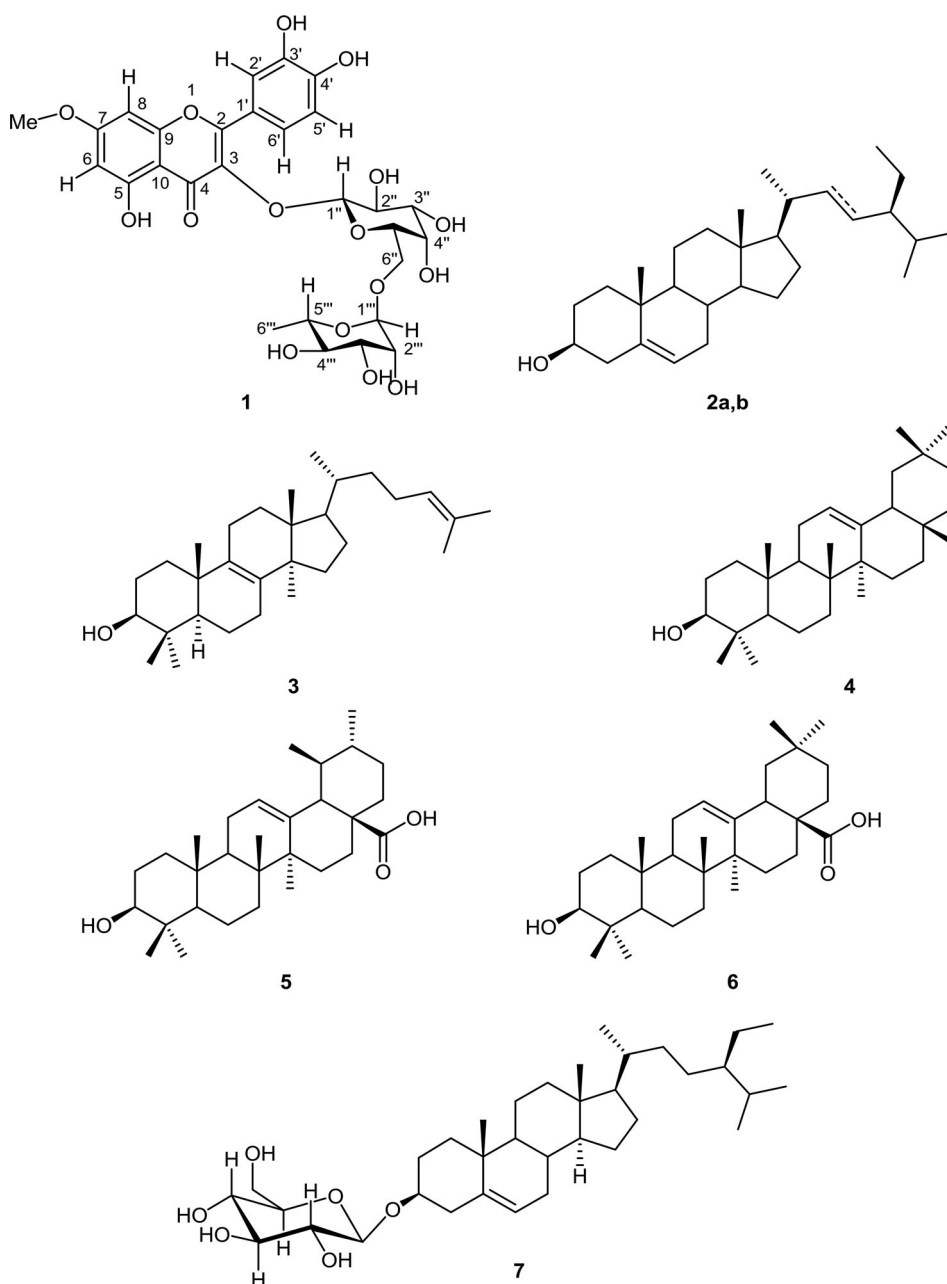


Figure 1. Structures of compounds 1-7.

for galactose (C-1'') and rhamnose (C-1'''). The resonance of one methyl group at δ_C 17.8 (C-6'') confirmed the presence of rhamnose. We can also observe the methoxy group appears at δ_C 56.5 ppm. The HMBC correlation spectrum (Figure 5S) permits us to locate on the aglycone moiety the position of the sugars moieties and the methoxy group. The spectrum shows a cross-peak correlation between the anomeric proton of β -galactose at δ_H 5.18 (H-1'') and the carbon at δ_C 133.9 indicating that the galactose unit is attached to

the aglycone on the carbone C-3. Furthermore, strong correlation is also observed between the anomeric proton of α -rhamnose at δ_{H} 4.55 (H-1'') and the oxymethylene carbon at δ_{C} 68.3 which is assignable to C-6'' of β -galactose, showing that rhamnose unit is linked to galactose on C-6'' carbon ($\alpha(1\rightarrow6)$ linkage). Protons of the methoxy at δ_{H} 3.91 group correlate with the carbon at δ_{C} 165.9 attributable to C-7 of the aglycone. Different others significant HMBC correlations are observed (Figure 6S). ^1H and ^{13}C NMR data of compound **1** are shown in Table 2S. The structure of **1** have been identified by the aid of literature data as rhamnetin-3-O-robinobioside which is isolated for the first time from natural sources. The trivial name tapinantocide have been given to the compound.

The known compounds were identified from their NMR spectroscopic data and comparisons made with those reported in the literature. A mixture of β -sitosterol (**2a**) and stigmasterol (**2b**) (Luhata and Munkombwe 2015), euphol (**3**) (Lin et al. 2012), β -amyrin (**4**) (Kopa et al. 2016), ursolic acid (**5**) (Basir et al. 2014), oléanolic acid (**6**) (Castellano et al. 2016) and 3 β -O-D-glucopyranosyl- β -sitostérol (**7**) (Sandjo, 2009). Compound **3** was isolated for the first from Loranthaceae family.

2.2. Anticancer activity

The result of the anticancer activity of the methanol extract and compound **1**, **3** and **7** of *Tapinanthus sp.* is presented in Table 1S. The methanol extract showed a very good anticancer activity against U87 MG cells ($\text{IC}_{50} = 21.40\ \mu\text{g/mL}$) and PC-3 cells ($\text{IC}_{50} = 10.26\ \mu\text{g/mL}$) compared to that of temozolomide used as standard. There is a few reported anticancer activity of species from Loranthaceae family, particularly from *tapi-nanthus* genus. A recent study demonstrated the anticancer activity of some species from Laranthaceae family (Oriola et al. 2018), showing that these species could play an important role in cancer treatment or prevention.

Compound **3** significantly inhibits the proliferation of PC-3 prostate cancer cells with $\text{IC}_{50} = 21.33\ \mu\text{M}$, while its cytotoxic effect was moderated on C6 ($\text{IC}_{50} = 38.84\ \mu\text{M}$) and U87 MG ($\text{IC}_{50} = 59.97\ \mu\text{M}$) glioblastoma cancer cells. The compound was more active than temozolomide, and less active than docetaxel, both used as standard (Table 1S). Previous study also showed that compound **3** (euphol) exhibits anticancer effect on a large panel of cancer cell lines (Silva et al. 2018). Compounds **1** and **7** were not active on all tested cancer cell lines. The inactivity of **1** and **7** could be due to the presence of sugar moiety. It's reported that sugar moiety influence negatively the antiproliferative activity (Qi et al. 2010). Compounds **2**, **4**, **5** and **6** were not tested. Therefore, these compounds are known for their anticancer activity, β -amyrin (**4**) (Chaturvedula et al. 2003), ursolic acid (**5**) (Batra and Sastry, 2013), oleanolic acid (**6**) (Zhu et al. 2015), and could be in part responsible for the higher cytotoxic effect observed with the related extract.

3. Experimental

3.1. General experimental procedures

The melting point of the new compound was recorded in an open capillary using Electrothermal 9100 and is uncorrected. The ^1H and ^{13}C NMR data were recorded on spectrometer Bruker Avance AV-500 and 600, and tetramethylsilane (TMS) was used as

standard. Chemical shifts are given in ppm (δ) and coupling constant (J) in Hz. The High Resolution Mass spectrum was registered on LC-MS-QTOF Spectrometer (Bruker, Germany) equipped with ESI source operating in positive mode. Column chromatography (CC) was performed on silica gel 60 (70–230 mesh, Merck), and Thin Layer Chromatography (TLC) was performed on silica gel precoated plates F-254 Merk (20 × 20 cm). Spots were visualised under UV light (254 and 365 nm), sprayed with 5% of phosphomolybdic acid prepared in ethanol, then heated.

3.2. Plant material

The leaves of *Tapinanthus sp.* (Loranthaceae) were collected during the month of May 2017 at Padarmé village located in Bibémi subdivision, North Region of Cameroon. The geographical coordinates of the place of collection of the plant are: Latitude 9.5304° or 9° 31' 49.4 '' North, Longitude 14.0617° or 14° 3' 42.1'' Est. *Tapinanthus sp.* is an unlisted plant species from the collection of plants listed at the National Herbarium of Cameroon (NHC) and no specimen in the herbarium had been found to match with this plant species. In Cameroon, only 26 species of plants from Loranthaceae family are listed at the National Herbarium. *Tapinanthus sp* could be a new species in the geographical area of Cameroon and need further investigation by botanists to list this plant at the National Herbarium of Cameroon. It's a hemi parasitic plant harvested on *Combretum glutinosum*, the host plant. This later have been identified at the National Herbarium of Cameroon under voucher number: 38091 HNC.

In collaboration with systematians, Prof Tonfack Libert Brice and Dr Kono Léon of our institution, a detailed description of the morphology, microscopic and photographs of the anatomical parts (see [supplementary materials](#)) of *Tapinanthus sp* have been provided. *Tapinanthus sp* is described as an epiphytic shrub with unique haustoria (**Picture 1S**). Stems spreading to 30 at 70 cm, generally puberulous at first, glabrescent, grey to brownish, branching abundantly in all direction in more or less twigs and hanging (**Picture 2S**). Its young organs are smooth and covered with small lentils. Leaves are mostly opposite and subopposite, decussate, with a short petiole (**Picture 3S**); lamina coriaceous, dull green, largely ovate-elliptic that can reach 10 cm in length and 5 cm in width, generally with 4-6 pairs of lateral nerves (**Picture 4S**). The inflorescence is an auxiliary umbel of 6 to 8 flowers with more or less long peduncle; head of buds are reddish, puberulent with short spreading hairs; bud heads oblong-ellipsoid to oblong-ovoid, rounded, slightly apiculate and angular (**Picture 5S**).

3.3. Extraction and isolation

The air-dried powder leaves of *Tapinanthus sp.* (1.30 Kg) was extracted by maceration in 7 L of methanol during 48 h with intermittent stirring. The obtained solution was filtered, followed by removing of solvent under reduced pressure using a rotary evaporator. The procedure of the extraction was repeated three times to afford 55 g of methanol crude extract. A quantity of the extract (26 g) was separated using glass column chromatography (h 1000 mm, Ø 50 mm) on silica gel and eluted with hexane-ethyl acetate (100:0 → 0:100%), then ethyl acetate-methanol (100:0 → 0:100%)

gradient system used as mobile phases. The 100 mL fractions were collected from the column chromatography and a total of 195 fractions were obtained and grouped into four series (A-D) according to their TLC profiles. All series (A-D) were presented in the form of a trail regards to their TLC profile and were not of interest. The isolated compounds crystallised in some obtained fractions. Then, compounds were filtered on a filter paper and washed with the solvent or system of solvent in which the compound crystallised. The column chromatography separation led to one new flavonoid glycoside isolated for the first time from natural source (compound **1**) and six other known compounds (Compound **2-7**).

3.4. General information's of compound 1

Compound 1: (Rhamnetin-3-O-robinobioside or 5,3'-dihydroxy-7-methoxy-3-O-robinobiosideflavonol): Yellow powder, m.p. 169.8-170.8, HRESI-MS(+) m/z 625.1745 ($[M + H]^+$ calcd. for 625.1690). ^1H NMR (δ , 500 MHz, MeOD): 6.37 (d, $J = 2.0$ Hz, H-6), 6.62 (d, $J = 2.0$ Hz, H-8), 7.72 (d, $J = 2.0$ Hz, H-2'), 6.91 (d, $J = 8.6$ Hz, H-5'), 7.68 (dd, $J = 8.6; 2.0$ Hz, H-6'), 3.91 (s, OCH_3 -7), 5.18 (d, $J = 7.7$ Hz, H-1'), 3.64 (m, H-2'), 3.55 (m, H-3''), 3.84 (m, H-4''), 3.49 (m, H-5''), 3.45 (m, H-6''), 4.55 (d, $J = 1.7$ Hz, H-1'''), 3.47 (m, H-2'''), 3.31 (m, H-3'''), 3.29 (m, H-4'''), 3.42 (m, H-5'''), 1.14 (d, $J = 6.1$ Hz, Me-6'''). ^{13}C NMR: 158.4 (C-2), 135.7 (C-3), 179.5 (C-4), 162.7 (C-5), 99.1 (C-6), 167.4 (C-7), 93.2 (C-8), 159.6 (C-9), 106.5 (C-10), 123.0 (C-1'), 116.0 (C-2'), 145.9 (C-3'), 149.9 (C-4'), 117.7 (C-5'), 123.6 (C-6'), 56.5 (OCH_3 -7), 104.5 (C-1''), 78.1 (C-2''), 75.7 (C-3''), 73.9 (C-4''), 77.2 (C-5''), 68.6 (C-6''), 102.4 (C-1'''), 71.4 (C-2'''), 72.1 (C-3'''), 72.2 (C-4'''), 69.7 (C-5'''), 17.8 (C-6''').

3.5. Anticancer activity

3.5.1. Cell lines and cell culture

The U87MG human glioblastoma cells line and C6 rat glioblastoma cells line were grown in Dulbecco's modified Eagle's medium (DMEM, 1 g/L glucose) containing GlutaMAXTM (Gibco) and sodium pyruvate (Invitrogen), supplemented with 10% of fetal calf serum and 1% of penicillin/streptomycin (Gibco). The PC-3 human prostate cancer cells line were maintained in the same condition except the use of DMEM medium with 4.5 g/L glucose. All cells line was maintained in a humidified incubator (95% air and 5% CO_2) at 37 °C.

3.5.2. XTT antiproliferative test

The U87 and C6 glioblastoma (GBM) cells, as well as the PC-3 prostate cancer cells were plated in 96-wells plate, respectively at a density of 5×10^3 , 3×10^3 and 4×10^3 cells/well in 100 μL of corresponding medium. Then, cells were allowed to attach overnight in growth medium. After a 24 h incubation, the medium was replaced with fresh medium containing different concentrations of the tested extracts (3.15 – 200 $\mu\text{g/mL}$). Control cells were treated with DMSO (0.5%) used to dissolve samples. After 72 h of treatment, cell viability was measured using the Cell Proliferation Kitt II (XTT, Promega, Madison, WI, USA) as recommended by the manufacturer. Briefly, 50 μL of XTT (2,3-bis[2-Methoxy-4-nitro-5-sulfophenyl]-2Htetrazolium-5-carboxyanilide inner salt) labeling reagent mixture solution was added in each well, and then the plate was incubated for 4 h. The XTT reagent is converted by the metabolically active cells into an orange

formazan dye, and the formazan formed is directly proportional to the living cells. The absorbance was measured at 490 nm using a spectrophotometric microplate reader.

4. Conclusion

The phytochemical study of *Tapinanthus sp.* resulted in the isolation of one new flavonoid glycoside tapinantoside (**1**) and six known compounds **2-7**. Their structures were elucidated by the aid of spectroscopy data analysis and by comparison with the existing literature data. The methanol extract of *Tapinanthus sp.* showed very good anticancer activity against U87MG, C6 and PC-3 prostate cancer cell lines. Compound **3** also inhibits significantly the proliferation of all tested cells, while compounds **1** and **7** were inactive. *Tapinanthus sp.* is reported here as an unlisted plant species at the National Herbarium of Cameroon. This results show that *Tapinanthus sp.* is a promising source of useful molecules for anticancer therapy.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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References

- Abdullahi Z, Anuka JA, Salawu AO, Hussaini IM. 2015. In-vivo antiplasmodial activity of methanol whole plant extracts of *Tapinanthus dodoneifolius* (DC) Danser in mice. *Afr J Pharm Pharmacol.* 9(37):936–942.
- Awouafack MD, Tane P, Morita H. 2017. Isolation and structure characterization of flavonoids, In *Flavonoids from biosynthesis to human health*. Chapitre 3, Gonçalo Justino, Universidade de Lisboa. <http://dx.doi.org/10.5772/67881>.
- Balle S. 1986. Loranthacées. In: Leroy JF, editor, *Flore du Cameroun*: Satabie B., D.G.R.S.T Yaoundé, p. 82.
- Basir D, Julinar J, Agustriana E, Untari B. 2014. Oxydation and acetylation of ursolic and oleanolic acid isolated from *Fragraea fragrans* fruits: antiproliferation of P388 leukemia cells. *Indones J Chem.* 14(3):269–276.
- Baskar R, Dai J, Wenlong N, Yeo R, Yeoh K-W. 2014. Biological response of cancer cells to radiation treatment. *Front Mol Biosci.* 1:24.
- Batra A, Sastry VG. 2013. Extraction of ursolic acid from *Ocimum sanctum* and synthesis of its novel derivatives: Effects on extracellular homocysteine, dihydrofolate reductase activity and proliferation of HepG2 human hepatoma cells. *Pteridines.* 24(3):191–199.

- Buschi CA, Pomilio AB. 1982. Isorhamnetin 3-O-robinobioside from *Gomphrena Martiana*. J Nat Prod. 45(5):557–559.
- Castellano JM, Guinda A, Macias L, Santos-Lozano JM, Lapetra J, Rada M. 2016. Free radical scavenging and α -glucosidase inhibition, two potential mechanisms involved in the anti-diabetic activity of oleanolic acid. Grasas Aceites. 67:142.
- Chaturvedula VSP, Schilling JK, Miller JS, Andriantsiferana R, Rasamison VE, Kingston DGI. 2003. New cytotoxic oleanane saponins from the infructescences of *Polyscias amplifolia* from the Madagascar rainforest. Planta Med. 69(5):440–444.
- IARC (International Agency for Research on Cancer). 2020. Latest global cancer data: cancer burden rises to 19.3 million new cases and 10.0 million cancer deaths in 2020. Press Release N° 292.
- Kopa TK, Tane P, Wabo HK, Tala MF, Tchinda AT, Zofou D, Ning-Hua T. 2016. Activité antiplasmodiale in vitro des composés isolés des écorces du tronc de *Vitex thyriflora*. CR Chim. 19(7): 807–811.
- Lin MW, Lin AS, Wu DC, Wang SS, Chang FR, Wu YC, Huang YB. 2012. Euphol from *Euphorbia tirucalli* selectively inhibits human gastric cancer cell growth through the induction of ERK1/2-mediated apoptosis. Food Chem Toxicol. 50(12):4333–4339.
- Luhata LP, Munkombwe NM. 2015. Isolation and characterisation of Stigmasterol and β Sitosterol from *Odontonema strictum* (Acanthaceae). J Innov Pharm Biol Sci. 1:88–95.
- Mabry TJ, Kagan J, Rosle H. 1964. Nuclear Magnetic Resonance Analysis of Flavonoids. The University of Texas Publication. NO. 6418, p. 44.
- Maza H, Mkounga P, Fenkam SL, Sado SK, Ishikawa H, Nishino H, Nkengfack EA. 2017. Triterpenoids from seeds of *Tapinanthus bangwensis*. Phytochem Lett. 19:23–29.
- Nickrent DL, Malecot V, Vidal-Russell R, Der JP. 2010. A revised classification of Santalales. Taxon. 59(2):538–558.
- Nwafuru S, Akunne T, Ezenyi I, Okoli C. 2017. Anti-inflammatory activity of leaf extract and fractions of *Tapinanthus bangwensis* (Engl. & K.Krause) Danser parasitic on *Citrus angustifolia*. EJMP. 21(3):1–10.
- Olennikov DN, Chirikova NK. 2018. Rhamnetin glycosides from the genus spiraea. Chem Nat Compd. 54(1):41–45.
- Oriola AO, Aladesanmi AJ, Arthur G. 2018. Anticancer activity of three African mistletoes. Niger J Nat Prod Med. 22:129–134.
- Patrick-Iwuanyanwu KC, Onyeike EN, Adhikari A. 2014. Isolation, identification and characterisation of gallic acid derivatives from the leaves of *Tapinanthus bangwensis*. J Nat Prod. 7:14–19.
- Qi L-W, Wang C-Z, Yuan C-S. 2010. American *ginseng*: Potential structure-function relationship in cancer chemoprevention. Biochem Pharmacol. 80(7):947–954.
- Sak K. 2012. Chemotherapy and dietary phytochemical agents. Chemother Res Pract. 2012:282570.
- Sandjo LP. 2009. Sphingolipides, Triterpénoïdes et autres métabolites secondaires des variétés sauvage et cultivée de l'espèce. *Triumfetta cordifolia* A. Rich. (Tiliaceae): Transformations chimiques et évaluation des propriétés biologiques de quelques composés isolés. Thèse de Doctorat/Ph.D en Chimie Organique, Université de Yaoundé I- Cameroun.
- Silva VAO, Rosa MN, Tansini A, Oliveira RJS, Martinho O, Lima JP, Pianowski LF, Reis RM. 2018. In vitro screening of cytotoxic activity of euphol from *Euphorbia tirucalli* on a large panel of human cancer-derived cell lines. Exp Ther Med. 16(2):557–566.
- Tarfa FD, Amos S, Temple VJ, Ocheke NA, Gamaniel KS. 2012. Hypoglycemic effects of the aqueous extract of African Mistletoe, *Tapinanthus sesselifolius* (P. Beauv) van Tiegh (Loranthaceae). Inter J Biol Chem Sci. 6:408–414.
- Vougat RR, Foyet HS, Ziebe R, Garabed RB. 2015. Antioxidant activity and phytochemical constituent of two plants used to manage foot and mouth disease in the Far North Region of Cameroon. J Intercult Ethnopharmacol. 4(1):40–46.
- Zhu Y-Y, Huang H-Y, Wu Y-L. 2015. Anticancer and apoptotic activities of oleanolic acid are mediated through cell cycle arrest and disruption of mitochondrial membrane potential in HepG2 human hepatocellular carcinoma cells. Mol Med Rep. 12(4):5012–5018.