

## Review Article

# Effects of extracts and molecules derived from medicinal plants of West Africa in the prevention and treatment of gynecological cancers. A Review

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**Abstract:** Medicinal plants are a potential source of drug discovery and development of new pharmacological compounds for cancer chemoprevention. More than 80% of the West African population uses medicinal plants. It is estimated that over 60% of approved anti-cancer agents are derived from plants. The plant raw material used in African traditional medicine and particularly in West Africa can be an important source for the research of anti-tumor drugs against gynecological cancers. These tumors have a negative impact on women's general health status and causes enormous health costs as they affect all age groups. Gynecological cancers remain thus a major concern worldwide, especially in West Africa where these cancers are the leading cause of cancer deaths in women. This review reports on the contribution of West African flora to the discovery of potential antiproliferative and/or cytotoxic phytochemical compounds against gynecological cancer cells. Scientific databases such as PubMed, ScienceDirect, Scopus and GoogleScholar were used to extract publications reporting West African plants and/or isolated compounds used in cell models of gynecological cancers. Thresholds of cytotoxicity and modes of action of these phytochemicals have been summarized. This research can serve as a basis for taking medicinal plants into account in the management of these gynecological cancers in resource-limited countries such as those in West Africa.

**Keywords:** Gynecological cancers, plant extracts, compounds, medicinal plants, West Africa

## Introduction

Women's cancer rates are increasing in low- and middle-income countries, with presentations that are often far advanced, requiring intense symptom management, thus advancing the urgent need to address palliative care [1]. Many patients report a negative impact on sexual identity and function, and their sexual relationship. Gynecologic cancer survivors are often the most severely affected. These cancers encompass tumors of the ovaries, uterus, cervix, vagina, and vulva [2]. Indeed, annual

cancer-related deaths are estimated at almost 600,000 in sub-Saharan Africa (SSA) region [3]. The burden of gynecologic cancers in low resource settings is overwhelming. Areas with the highest needs have few human resources and limited infrastructure. Hence cancer specialists can best help by leveraging ongoing work to assist local leaders [4].

Providing palliative care for women with cancer is constrained by human and physical resources, lack of equipment and access to healthcare equipment and staff, and health policy absence

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**Figure 1.** Map of ECOWAS with the representation of the 15 member countries. Source: <http://www.ecowas.int/member-states/>.

or barriers [1]. Cervical and breast cancers are consistently the two most common cancers in women across sub-Saharan Africa [5, 6]. The incidence and mortality of cervical cancer are both far higher in SSA than in more developed regions, while breast cancer has been observed to present in more advanced stage and to carry a far higher case fatality rate than in other regions. Cancer treatment in the context of SSA's limited resources is therefore a major challenge [4]. Indeed, SSA is vast and extremely diverse region, comprising several sub-regions, 47 countries and about one billion people. West Africa includes mainly the 15 member countries of Economic Community of West African States (ECOWAS): Benin, Burkina Faso, Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Sierra Leone and Togo (**Figure 1**) (<http://www.ecowas.int/member-states/> Modified by BAYALA Bagora et al.) Traditional herbal medicine could thus be considered as a main alternative for the treatment and prevention of gynecological cancers and an incalculable source of drug discovery [7,

8]. Between 1983 and 1994, 61% of approved anti-cancer agents were derived from plants [9]. Thus, the purpose of this review is to assess the effects of extracts and/or molecules derived from medicinal plants of West Africa in the prevention and treatment of gynecological cancers.

### *Role of medicinal plants of West Africa in the treatment of non-communicable diseases*

Non-communicable diseases (NCD) globally constitute major public health problems, with an impact on morbidity and mortality ranking high and second to HIV/AIDS. Existing studies conducted in South Africa pointed out that people living with NCD rely on traditional herbal medicine primarily or in combination with conventional drugs [10]. Most African people accept herbal medicines as generally safe with no serious adverse effects. However, the overlap between conventional medicine and herbal medicine is a reality among countries in health systems transition, mainly in West Africa [11]. Patients often simultaneously seek treatment

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from both conventional and traditional health systems for the same condition [11]. *Allium sativum*, *Brassica oleracea*, *Turmeric longa*, *Daucus carota*, *Cinnamomum cassia*, *Cinnamomum zeylanicum*, *Syzygium aromaticum*, *Thymus vulgaris* and *Zingiber officinale*, for example, have been widely used for the treatment of metabolic syndrome [12]. Various herbal medicines have been recommended for diabetes treatment together currently available therapeutic options [13], because of their no or less side-effects [14]. Besides, vegetables such as cabbage (*Brassica oleracea*), green leafy vegetables, beans and tubers are hypoglycemic in laboratory animals as well as in humans [15].

Most people in Africa developing countries depend hence on herbal remedies for effective treatment of wounds. Various *in vitro* and *in vivo* parameters are used for the evaluation of the functional activity of medicinal plants by using extracts, fractions and/or isolated compounds [16].

*Cissus aralioides*, *Securidaca longipedunculata*, *Piliostigma thonningii*, *Nauclea latifolia*, *Ocimum gratissimum* and *Newbouldia laevis* are widely reported to be used in the treatment of endemic diseases in Togo and neighboring countries [17]. These plants often contain highly potent chemical compounds, such as quinones, xanthenes, tannins and terpenes and therefore may provide an alternative avenue to short-term treatment [17]. *Chromolaena odorata* (L.) has likewise many uses. Ethnopharmacology recommends using it against malaria, wounds, diarrhea, skin infection, toothache, dysentery, upset stomach, sore throat, convulsions, piles, coughs and colds [18].

*Calotropis procera* and *Balanites aegyptiaca* are used extensively in Burkina Faso and the antitumor activity of extracts from various parts of these plants has been demonstrated [19]. Anti-inflammatory and antiproliferative activities of the essential oils of *Ocimum basilicum*, *Ocimum americanum*, *Hyptis spicigera*, *Lippia multiflora*, *Ageratum conyzoides*, *Eucalyptus camaldulensis* and *Zingiber officinale* used in traditional medicine in Burkina Faso have also been demonstrated [20]. In addition, the essential oils of *Cymbopogon giganteus* and *Cymbopogon citratus* from Burkina Faso present antioxidant and anti-inflammatory activities, together with anti-proliferative properties against

prostate cancer and glioblastoma cell lines [21].

### *Inventory of the situation of gynecological and mammary cancers in West Africa*

GLOBOCAN 2018 study [22] estimated 18.1 million new cancer cases and 9.6 million cancer deaths in 2018. Among females, breast cancer is the most commonly diagnosed, with 2.1 million new cases in 2018, and accounts for almost 1 in 4 cancer cases among women. This tumor is followed by cervical cancer which ranks fourth for both incidence and mortality of all cancers (570,000 cases and 311,000 deaths), ovary (1.6% cases and 1.9% deaths), vulva (0.2% and 0.2%) and vagina (0.1% of cases and 0.1% of deaths) cancers. Gynecological malignancies contribute thus to the global burden of diseases and are a real public health concern [22]. Our research covers the period from 1998 to 2018. For few countries (Cabo Verde, Guinea, Gambia, Liberia, Sierra Leone) no work was found in the consulted databases.

### *Burkina Faso*

Vulva cancer could be considered as a rare form of tumor in Burkina Faso. Twenty-one cases were reported within 30 months, ranking it as the 4th most common gynecological cancer. The average time from the first symptoms to the first consultation was 29 months. One fourth of the patients were at stage III or IV. The sensitization of the population and education for self-examination would definitely allow an earlier diagnosis [23]. Conversely, breast cancer study showed that high grade (II and III) represents 93.75% of the cases, with stages III and IV accounting for 50.0% [24]. This shows that there is a delay in diagnosis, as in the Benin studies. Furthermore, genetic analysis targeting the BRCA1 gene mutations c.68\_69delAG (exon2), c.181T>G (exon5), c.798\_799delTT and 943ins10 (exon11) was negative. Hence a complete sequencing of BRCA1 and BRCA2 genes in families at a high risk of developing breast cancer in Burkina Faso would be useful [25].

### *Nigeria*

A study from Ibadan, a city located in South West of the country, between 1981 and 2008

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found that vaginal and vulva cancers were the 4th (1.4%) and 5th (1.2%) most commons of the 5,913 diagnosed gynecological cancers [26]. Conversely, the close city of Ilorin pointed out a total of 166 gynecological malignancies, among them cervical cancer was the most common (59.6%), followed by ovarian (21.1%) and uterus (6.0%) tumors. Others included cancer of the vulva (3.6%) and of the vagina (1.8%) [27]. The high incidence of gynecological cancers underlies the importance of screening programs and awareness campaign in Nigeria [28]. Indeed, between 2002-2007 in Lagos, the respective levels of death were due to cervix (44.7%), ovary (29.8%), endometrium (6.4%) and vulva (1.1%) cancers [29, 30]. Likewise, in North Eastern, cervix cancer was the most common (70.5%), followed by ovary (16.3%), and uterus (8.5%) cancers [28] between 1991 and 2000. In Sagamu, cervical cancer was the most common tumor (51.6%), followed by ovarian (35.4%), endometrial (9.9%), and choriocarcinoma (1.9%) between 2004 and 2013 [31]. In Kano, a total of 249 malignancies were identified with the most (48.6%) being cervix cancer, followed by ovarian (30.5%) and endometrial (11.25%) cancers, and choriocarcinoma (9.24%) between 2008 and 2011. Estimates of this important public health problem need to be addressed in various regions of Nigeria [32]. Therefore, cervix cancer seems to have the leading causes of mortality and the most adverse effects of gynecological cancers in Nigeria, while this cancer ranks fourth for both incidence and mortality among women worldwide [22]. The highest regional incidence and mortality rates are seen in Western Africa (Guinea, Burkina Faso, and Mali) [22]. Furthermore, 48% of the women analyzed had endometrium lesions in Ibadan between 2008 and 2010, demonstrating that researchers, and clinicians are needed to increase the awareness of endometriosis among the public [33].

As for patient management, the delay in diagnosis and derisory management seems to take precedence over adequate measures to deal with cancer. Consequently, breast tumors are diagnosed at very late stages [34]. Likewise, 81% of the ovarian cancer patients presented stages III and IV. Only 23.8% had adjuvant therapy, consisting of combination chemotherapy using cisplatin-based regimes. The fatality rate 6 months after surgery was 76% [35]. In Newei, over a 12 years period (1998-2009), 867 gynecological malignancies were detected and vulva carcinoma accounted for 1.27%, among them stage III represented the majority of the cases (45.4%) [36], while in Lagos, 86.5% of the ovarian cancer patients were diagnosed with stages III and IV [37]. All patients had surgery as 1st line treatment. It should be noticed that surgery and radiotherapy remain the main therapeutic approach in Nigeria and is usually highly successful when performed early [36]. Nigeria is characterized by patient-related delays in presentation, provider-related delays in referrals and poor compliance with recommended chemotherapy [37]. The factors concerning gynecological malignancies awareness and health care access, rather than intrinsic tumors characteristics, are the strongest determinants of stage at diagnosis [34]. These results show that even within the richest country in West Africa, the problem of delayed diagnosis and access to care remains a challenge in this part of Africa.

*Ghana*

Throughout the country, 3,500 gynecological cancers were recorded between 2000 and 2014. Among them, cervix cancer represents 80.4% [38]. In Accra, cervical tumor was the most common cancer (58%) during a period of 52 months, followed by ovarian or endometrial cancer, choriocarcinoma and vulvar carcinoma. Most patients with cervical or ovarian carcinoma presented an advanced disease conversely to the patients with an endometrial carcinoma [39-41]. Furthermore, triple-negative breast cancer (TNBC) prevalence is higher among women with African ancestry and represents the most common subtype of breast cancer seen among of Ghanaian women, regardless of age, tumor grade, or stage of diagnosis [42]. In 2010, 223 breast cancers, with more than half were TNBC (58.3%), were observed in Korle Bu teaching hospital. Altogether, Ghanaian patients with a breast cancer tend to have a more advanced stage tumor, with a relatively younger age at diagnosis compared to Caucasian Americans and African Americans [42]. In conclusion, diagnosis and management of these more advanced gynecological cancers are two major challenges in Ghana [38]. Improvements in the preventive strategies could indeed considerably reduce the burden of gynecological cancers in Ghana [40].

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### *Niger*

One study on gynecological cancers was found. During the period of 2010-2013, 245 breast cancers were identified in Niamey. Only 37.1% of them had histopathologic confirmation and 90% presented advanced stages; mastectomy was performed in 66% of the cases. Implementation of clinical guidelines are an important need for reducing breast cancer morbidity and mortality in Niger [43]. This situation shows how much effort is needed for the prevention and treatment of cancer in Niger.

### *Senegal*

In this country, breast cancer occurs in young women. Indeed from 2010-2014, a retrospective and prospective study only found 188 breast cancers in Dakar, however with a mean age at diagnosis of 43.3 years [44]. Likewise, between 2007 and 2015, 62 women younger than 35 years were diagnosed with a breast cancer. Their mean of time to consultation was 12.5 months, and the disease was locally advanced at the time of diagnosis in 79% of cases. Among them, 19.4% were positive for the steroid receptors and 12.9% had an overexpression of HER-2. Chemotherapy was performed in 87.1%, and surgery in 62.9%. Recurrence occurred in 19.4% and 35.5% women died with a survival mean of 36.7 months [45].

### *Togo*

During a period of 8 years [46], a retrospective study found 1,738 cancers, with breast cancers (9.9%) being the most frequent, followed by the cervix (7.2%). Cancers are frequent in Togo. Those of the breast and cervix being are the most important with a worse prognosis. As for the other countries, emphasis should be placed on early detection and diagnosis [46].

### *Mali*

No prevalence study has been available so far. However, a study analyzed the main barriers impeding the patients to go through a breast cancer diagnosis. It appeared that the low level of knowledge about this cancer was important, not only among the women, but also their families and more surprisingly the medical professionals. Low quality of health care services, lack of social support, economic hardship, high

costs and lack of specialized services were also pointed out by the study [47].

### *Ivory coast*

Cervical cancer is the most common cancer among women and the leading cause of cancer deaths in women in Ivory Coast [48]. The hormonal receptor status is associated with the age and the histologic grade in breast cancer patients. The 20 months prospective study included 302 patients in Abidjan. Grade 2 tumor was more frequent in 55%. The estrogen (ER+), progesterone (PgR+) and ER-PgR- are the most common subgroups. Among 302 patients, 56% and 49% expressed ER or PgR respectively. The ER+PgR+ group was predominant (43%) [49].

### *Benin*

Epidemiological of study in Parakou covering six years found 90 cases of gynecological and breast cancers. Cervical cancer was the leading one with 55%. Breast cancer accounted for 34%, followed by ovarian cancer (6%) [50]. Among 494 gynecological cancer cases diagnosed (period of 10 years) in the University of Benin Teaching Hospital, 6% had confirmed histological diagnosis of vulva cancer following by cervical (63%), ovarian (17.0%) and endometrial cancers (7%) [51]. As previously pointed out, early detection of these tumors needs to be highly promoted [50]. Indeed, for the study of Parakou, the median time from the onset of first symptoms to first consultation was  $92 \pm 71$  days. Most cancers (60%) were diagnosed at an advanced stage (stage II, III or IV) [50]. Likewise, for vulva cancer, poor educational and socioeconomic background likely influenced late presentation of patients. Good public enlightenment could influence early presentation positively [51]. Patients mainly only went under surgery [50]; 57% of the patients had chemotherapy while 11% of patients had radiotherapy with surgery [51].

### **Effects of plant extracts and cytotoxicity threshold**

Ovarian cancer in Lagos, Nigeria is characterized by patient-related delays in presentation, provider-related delays in referrals. According to these studies, private hospitals (35.1%) and herbal homes (21.6%) were the commonest facilities first visited in Nigeria [37]. So far,

about 400 compounds from African medicinal plants have shown to have *in vitro* and/or *in vivo* anticancer, cytotoxic, and/or antiproliferative activities. This makes African flora a source of potential anticancer drugs. Naturally occurring anticancer compounds represent about half of the chemotherapeutic drugs. In Cameroon, the majority of the 390 identified compounds belongs to the terpenoid class (31%), flavonoids, alkaloids, and steroids. The plant family with a majority of cytotoxic, antiproliferative and anticancer agents is the Rutaceae family (14.1%), followed by the Moraceae, Leguminosae, and Rubiaceae families, respectively, representing 8.8%, 8.7%, and 4.5% [52]. The work carried out in West Africa on cell lines developed from gynecological cancers is listed and summarized in **Table 1**. *Pavetta crassipes* K. Schum (Rubiaceae) is widely distributed throughout West Africa. Its traditional medicinal remedy was confirmed using cytotoxicity assays *in vitro*, which found that leaves exhibited antitumor activity against the cancer cells U373, PC3, MXT and A549, as well as the normal cell lines NHDF and MRC-5 [53]. *Jatropha curcas* (JCP1), *Pyrenacantha staudtii* (PS), *Picralima nitida* (ZI) and *Jatropha gossypifolia* (JCP2) are plants used in African folklore for the treatment of various cancers. All four plant extracts mediate strong anti-proliferative properties on human epithelial MCF-7 breast cancer cells with  $IC_{50}$  values between 23-38  $\mu\text{g/ml}$ . At a concentration of 10  $\mu\text{g/ml}$  PS, JCP1 and JCP2 also increase the cell death. ZI extract was the exception by the increasing  $\beta$ 1-integrin expression and strengthening the cortical actin cytoskeleton [54]. Furthermore, *Markhamia tomentosa* (Benth) K. Schum ex. Engl. (Bignoniaceae), widely dispersed in West Tropical Africa, is traditionally used to treat various diseases and present antioxidant, analgesic, anticancer and anti-inflammatory activities. Cell viability and growth of HeLa (cervix adenocarcinoma) cells was inhibited with an  $IC_{50}$  of  $189.1 \pm 1.76 \mu\text{g/ml}$  at 24 h post treatment and was toxic to brine shrimps with  $LD_{50}$  of 31.62  $\mu\text{g/ml}$  [55]. For 30 healers from Nigeria, cytotoxicity was observed in 5 species (*Acanthospermum hispidum*, *Cajanus cajan*, *Morinda lucida*, *Nymphaea lotus* and *Pycnanthus angolensis*) on MCF-7 cells and on normal keratinocytes SVK-14. *Acanthospermum hispidum* and *Cajanus cajan* were the most active [56]. Likewise, in Nigeria, root bark of *Persea americana* demonstrated anti-

proliferative activity against ER<sup>+</sup> MCF-7 cells [57]. *Sapium ellipticum* leaves from Nigeria showed activity comparable to the reference compound cisplatin on HeLa cells and greater cytotoxic activity than *Combretum paniculatum*, *Celosia trigyna*, *Drymaria cordata*, *Cyathula achyranthoides* and *Cyathula prostata*. *Justica extensa*, *Pupalia lappacea*, *Hedranthera barteri* leaves, *Alternanthera sessilis*, *Ethulia conyzoides* leaves, *Combretum zenkeri* root, *Sapium ellipticum* stembark and *Lannea nigritana* stembark showed very low activity [58]. In Burkina Faso, 78 mM Kurubasch aldehyde, a sesquiterpenoid from *Trichilia emetica* Vahl. (Meliaceae) slow down the proliferation of MCF-7 cells [59]. Significant antiproliferative activity against breast cancer cells MDA-MB 231 was found for *Holarrhena floribunda* isolated from Guinea-Bissau [60]. Antioxidant and cytoprotective activities of boiled, cold, and methanolic extracts of nine edible vegetables from Southwest Nigeria were evaluated. Interestingly, all these extracts show a strong antioxidant activity at high concentrations of 1 or 5 mg/mL [61]. Indeed, edible vegetables in Southwest Nigeria as *Crassocephalum rubens* showed the highest antioxidant activity (56.5%), while *Solanum americanum* and *Vernonia amygdalina* exhibited moderate antioxidant activity (26.0-37.5% and 14.8-36.2%, respectively). *Solanum macrocarpon*, *Telfaria occidentalis*, *Amaranthus hybridus* and *Jatropha tanjorensis* produced weak activity, while *Celosia argentea* and *Talinum triangulare* were pro-oxidants [61]. A novel water-soluble leaf extract of *Vernonia amygdalina* potently inhibited DNA synthesis of MCF-7 cells, and *Vernonia amygdalina*, if incorporated in the diet, and may prevent or delay the on-set of breast cancer [62].

### Mechanism of action of plant extracts and molecule on gynecological cancers

While derived plant extracts and molecules have been extensively tested on gynecological cancers in West Africa, few studies however have deciphered the molecular mechanisms. Catechins and polyphenols from plant extracts such as green tea show the strongest anticancer activity and modulate the activity of protein kinases involved in signal transduction cascades. They also show both cytostatic and cytotoxic activity towards breast cancer cells [63]. Thonningiol and seputhecarpan D induce cell

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**Table 1.** Medicinal plants study on gynecological cancer lines cells in West Africa (1998-2018)

Country	Family species Compounds	Part of plant and Extract	Cell line used IC <sub>50</sub>	Local ethnobotanical information	References
Guinea-Bissau	APOCYNACEAE <i>Holarrhena floribunda</i> (G. Don) T. Durand & Schinz Synonyms: <i>H. africana</i> A. DC.; <i>H. wulfsbergii</i> Stapf; <i>Rondeletia floribunda</i> G. Do	Stem Ethanol	MDA-MB 231 (breast cancer) 9.9 µg/ml	Antidote against poisonous snake bites	[60]
Guinea	RUBIACEAE <i>Pavetta crassipes</i> K. Schum	Leaves	MXT (mouse mammary carcinoma) Mean IC <sub>50</sub> (µg/ml): MXT was 37.0 ± 3.0		[53]
Benin	-EUPHORBIACEAE <i>Jatropha curcas</i> Linn (JCP1)	Root bark. Ethanol	MCF-7 (breast cancer) IC <sub>50</sub> MCF-7 (µg/ml): JCP1: 36.55	JCP1: cough, wound healing, HIV, cancer	[54]
	-ICACINACEAE <i>Pyrenacantha staudtii</i> Hutch & Dalz (PS)	Leaf.	MCF-7 (breast cancer)	PS: threatened abortion, malaria, GIT and cancer	
	-APOCYNACEAE <i>Picralima nitida</i> Th. & H. Durand (ZI)	Root bark. Ethanol	MCF-7 (breast cancer) IC <sub>50</sub> MCF-7 (µg/ml): ZI: 22.76	ZI: malaria, hyperglycaemia, antiseptic etc	
	EUPHORBIACEAE <i>Jatropha gossypifolia</i> Linn (JCP2)	Root bark. Ethanol	MCF-7 (breast cancer) IC <sub>50</sub> MCF-7 (µg/ml): JCP2: 25.55	JCP2: cancer, pesticides Owan	
Nigeria	-EUPHORBIACEAE <i>Plukenetia conophora</i> Müll Arg (PCL)	PCL: Leave. CCL:	MCF-7 and MCF-12A (breast cancer)	PCL: Cancer, stomach pain, infertility	[57]
	-STERCULIACEAE <i>Cola lepidota</i> (CCL)	Seeds. HUL:	MCF-12A: between proliferative %: 0.15 ± 0.05 and 87.75 ± 6.60	CCL: Cancer, bacterial infections, infertility	
	-APOCYNACEAE <i>Hunteria umbellata</i> (HUL)	Leaves. PAL:	MCF-7: between proliferative %: 1.23 ± 0.76 and 82.66 ± 12.23	HUL: Cancer, cough, diabetes, inflammations	
	-LAURACEAE <i>Persea americana</i> leaf (PAL)	Leaves. RPA: Root		PAL: Cancer, inflammation	
	-LAURACEAE <i>Persea americana</i> (RPA)	Methanol		RPA: Cancer, threatened abortion, ulcer	
	-BIGNONIACEAE <i>Markhamia tomentosa</i> (Benth) K. Schum ex. Engl.	Leaf	HeLa (cervix) MCF-7 (breast cancer) LD50 of 31.62 mg/ml Cytotoxic effects of HeLa cells: IC <sub>50</sub> of 189.171.76 mg/ml at 24 h post treatment	Antimicrobial, antioxidant, analgesic, anticancer and anti-inflammatory activities	[55]
	-ASTERACEAE <i>Vernonia amygdalina</i> (VA)	Water-soluble leaf	MCF7 (breast cancer) Cytotoxic effect of VA extract on MCF-7 cells after 48-hr: The percentages of cell viability were 100 ± 5, 60.9 ± 7, 37.3 ± 9.2, 23.7 ± 9.5, and 19 ± 5% for 0, 3, 6, 12.5, and 25 µg/ml Vernonia amygdalina extract, respectively IC <sub>50</sub> was computed 5.68 ± 0.2 µg/ml	Vegetable in the diets of many Nigerians and other West Africans	[62]
	FABACEAE <i>Cajanus cajan</i> Millsp. Compounds: longistylins A and C	Leaves Methanol	MCF-7 (breast cancer) 5-10 µg/mL	No information	[56]

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	-EUPHORBIACEAE <i>Sapium ellipticum</i> (Krauss.) Pax.	Leaves	HeLa (cervix) Potentially, cytotoxic are <i>Sapium ellipticum</i> leaves, <i>Combretum paniculatum</i> leaves,	No information	[58]
	-COMBRETACEAE <i>Ombretum paniculatum</i> Vent.	Stembark	<i>Celosia trigyna</i> , <i>Drymaria cordata</i> and <i>Cyathula</i>		
	-AMARANTHACEAE <i>Celosia trigyna</i> L	Leaves	<i>prostata</i> showing over 50% activity at 500 µg/ml, moderate cytotoxic are <i>Ethulia conyzoides</i> leaves, <i>Hedranthera barteri</i> leaves and <i>Cyathula achyranthoides</i> showing between 40-50% activity		
	-AMARANTHACEAE <i>Pupalia lappacea</i> (L.) A. Juss	Whole plant	At 500 µg/ml and low cytotoxic activities are <i>Pupalia lappacea</i> , <i>Justica extensa</i> , <i>Sapium ellipticum</i>		
	-ACANTHACEAE <i>Justica extensa</i> T. Anders	Whole plant	<i>Stembark</i> , <i>Alternanthera sessilis</i> , <i>Lannea nigritana</i> stem-bark and <i>Combretum zenkeri</i> root showing less than 40% activity at 500 µg/ml.		
	-APOCYNACEAE <i>Hedranthera barteri</i> (Hook. f.) Pichon	Whole plant	Non-toxic are <i>Combretum molle</i> , <i>Adenantha parvoniana</i> fruit and <i>Lannea acida</i> stem bark with no activity against the HeLa cell line		
	-AMARANTHACEAE <i>Alternanthera sessilis</i> L. DC	Leaves			
	-ASTERACEAE <i>Ethulia conyzoides</i> Linn. F	Whole plant			
	-ANACARDIACEAE <i>Lannea nigritana</i> (Scott Elliot) Keay SB	Leaves			
	-COMBRETACEAE <i>Combretum zenkeri</i> Engl. & Diels	Stembark			
	-COMBRETACEAE <i>Combretum molle</i> R. Br	Root			
	-MIMOSACEAE <i>Adenantha parvoniana</i> L	Leaves			
	-ANACARDIACEAE <i>Lannea acida</i> A. Rich	Fruits			
	-AMARANTHACEAE <i>Cyathula achyranthoides</i> (Kunth.) Moq	Stembark			
	-CARYOPHYLLACEAE- <i>Drymaria cordata</i> (Linn.) Willd	Whole plant			
	-AMARANTHACEAE- <i>Cyathula prostata</i> (Linn.) Blume	Whole plant			
Ivory Coast	-Asteraceae <i>Chromolaena odorata</i>	Leaves ( tree compounds isolated: C1, flavanone C2, chalcone and C3, cadalene)	C2 at 20 mM decreased cell viability of Cal51, MCF7 and HeLa cells by 19%, 18% and 30%, respectively. Compounds C1, C2, C3 and resveratrol were all tested against line Cal51. Only resveratrol caused any induction of apoptosis when exhibited alone. However, when exhibited in association with ABT737 (1 mM), the chalcone C2 (10 mM) caused an approximately threefold enhancement relative to when either chalcone or ABT737 was exhibited alone, indicating a significant synergistic effect	Treatment of malaria with aqueous extracts	[73]
Burkina Faso	MELIACEAE <i>Trichilia emetica</i> Vahl. [synonyms <i>T. somalensis</i> Chiov., <i>T. jubensis</i> Chiov., <i>T. roka</i> (Forssk.Nom.Nud.) Chiov, <i>Rhoche-tia choensis</i> Del.] Kurubasch aldehyde	Roots  MeOH	MCF7 (breast cancer) 78 ± 15 mM	No information	[59]

According to the results of our research, no scientific study on the activity of medicinal plants on gynecological cancers has yet been carried out in Mali, Senegal, Gambia, Sierra Leone, Liberia, Ghana, Togo, Niger and Cape Verde.



cycle arrest in G<sub>0</sub>/G<sub>1</sub> whilst doxorubicin induced arrest in G<sub>2</sub>/M. These two molecules also induce apoptosis of MCF-7 cells through activation of caspases 3/7 [12]. *Emblica officinalis* extract modulates the proliferation of ovarian cancer cells and the tumor microenvironment via the induction of miR-375 and by targeting IGF1R and SNAIL1 [64]. The activity of caspase 9 representing the endogenous apoptotic pathways is increased by the oleanen compound extracted from *Celastrus hypoleucus* [65]. Furthermore, the increase in the expression of pro-apoptotic Bim was the most significant among the Bcl-2 family after oleanen treatment. The extract of *Markhamia tomentosa* induces HeLa cell cycle arrest in the G<sub>0</sub>/G<sub>1</sub> phase resulting in cell death after 24 h exposure. Induction of apoptosis in HeLa cells was substantiated by Annexin V-FITC/PI double staining showing phosphatidylserine translocation and depolarisation of the mitochondrial membrane potential by flow cytometry of JC-1 stained cells [55].

### Some traditional medicines improved against gynecological cancers

Beside efficient but really expensive treatments [66], a large number of improved traditional plants and medicines have been used in the management of gynecological cancers. An increasing number of *in vitro* and *in vivo* studies have shown that polyphenols extracted from traditional plants could be used as agents for the prevention of multiple cancerous diseases including gynecologic cancer [67]. Many studies have shown that diet, including the consumption of lipids and natural antioxidants, can strongly influence breast and prostate cancer and that argan oil, thanks to its polyphenol content, can contribute to the prevention of a number of cancers including prostate cancer [68]. More recent research has described the anticarcinogenic activities of curcumin, resveratrol and epigallocatechin-3-gallate (EGCG) for the treatment of cervical cancer [69]. The inhibitory effects of green and black tea in the treatment of cancer have been extensively studied. Polyphenols in flavan-3-ol tea are potent bioactive compounds that interfere with cancer initiation, development and progression through critical processes [70, 71].

They have the ability to interrupt or reverse the process of carcinogenesis by acting on the

intracellular signaling network molecules involved in the initiation and/or promotion of cancer to stop or reverse the phase of cancer progression [72]. The polyphenols can also trigger apoptosis in cancer cells through modulation of a number of key elements involved in cell signaling [72].

### Conclusion

Gynecological cancers are a real problem of public health in West Africa mainly resulting from diagnosis delay, which provokes a high rate of morbidity and mortality. Besides, due to the low-income situation, patients do not always have the capacity to face expensive pharmacological treatments, which obviously aggravates the prognosis issue. Our review has demonstrated that compounds extracted from traditional herbal medicine could be an interesting alternative together with a clear potential source of drug discovery useful for developing countries such as West Africa. However, to reach a translational level will need pharmacological analyses using cell culture and *in vivo* experiments using animal models. This will be the future challenge.

### Disclosure of conflict of interest

None.

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