Int.J.Curr.Microbiol.App.Sci (2022) *11*(02): 353-360

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 11 Number 02 (2022)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2022.1102.040

Phytochemical Evaluation and Uses of *Ximenia americana* L in Central Darfur

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Keywords

Ximenia americana, Ethnobotany, Folk remedy, phytochemical

Article Info

Received:
01 January 2022
Accepted:
02 January 2022
Available Online:
10 February 2022

A B S T R A C T

Ximenia americana bark, leaves, and fruits which belong to the family Olacaceae traditionally used for the treatment of different human ailments. The study was conducted to evaluate the scientific basis for the use of the plant. Chemical constituents of the extract were also determined. The extract was active against different microbiological organisms were found. Phytochemical screening extract showed the presence of saponins, few alkaloids, tannins, flavonoids, terpenes, triterpenes sterols, and coumarins in all extracts and fractions. Anthrax-quinones, starch, general glycosides, and bitter principles were found to be present in the extract. The study supports the traditional use of this plant by herbalists as a remedy and curing different ailments.

Introduction

In Sudan *Ximenia americana* tree, family Olecaceae is widely distributed in different regions. It is found in Darfur (Jabal Marra, Radom); Blue Nile (Ingessena Hills); Kordofan (Nuba Mountains, Nuhud); Red Sea Hills (Erkwit); Bahar Ghazal, Upper Nile and Equatoria (Torit). *X. americana* bark, fruit and leaves have many uses in local medicine for people and animals (Saeed and Bashier, 2010) and (Kefelegn and Desta, 2021). The fruit is a rich source of vitamin C and contains hydrocyanic acidriproximin (Paulino and Umesh, n.d.). *Ximenia americana* L. (Olacaceae), also known as 'wild plum', 'yellow plum' or sea Lemon is a semi-scan dent shrub or small tree with small elliptic leaves and whitish to yellowish-green flowers borne in small cymes. *X. americana* is currently widespread throughout tropical and subtropical countries in Central and Southern America, Africa, India and Southeast Asia to Australia, New Zealand, and Pacific islands (Urso *et al.*, 2013).

In developing countries, new drugs are not often affordable. Thus, up to 80% of the population use medicinal plants as remedies. WHO (1978) notes that of 119 plant-derived pharmaceutical medicines,

about 74% are used in modern medicines in ways that correlate directly with their traditional uses as plant medicines by native cultures.

The plant is a bushy and spiny shrub or small tree, 4-5m high with open crown. The fruits are green but turn golden yellow or red when ripe. The fruit consumed when it turns yellow and it has a refreshing and acid taste (Feyssa *et al.,* 2012). Traditionally, the extract of the plant used in the treatment of diseases like skin infections, ulcer, leprosy, malaria and Trypanosoma congolense infection in mice (Length, 2008). It was believed that the plant have anti-inflammatory action and antimicrobial activity and use to cure rheumatic pain.

This specie is widely used in folk medicine of different countries to treat several human ailments. Leaves, barks, peeling and roots used in different African countries for treating toothaches, mumps and conjunctivitis in frontal applications (Wagga *et al.,* 2013). Many medicinal uses have been reported including treatments for headaches, toothaches, fevers, constipation, leprosy, infections of the eyes and ears(Biodiversity and Plan 2018). A *Ximenia americana* bark and leaves traditionally used for treatment of different human ailments. The bark powder was successively extracted by petroleum ether and methanol using cold extraction method (maceration) (Ali *et al.,* n.d.).

An Ethnobotanical survey carried with plants used in African medicine showed that the pulverized root of *X. americana* L. was used for leprosy and associated with Guiera senegalensis, which is used against syphilis. The fruits, as well as the leaves consumed as anthelmintic, active against worms and diarrhea (Gaichu *et al.,* 2017b).

Others studies showed that *X. americana* was used for inflammations in general for healing, urinary tract infection, diarrhea, anti-parasitic, mental illness, leprotic ulcers, antiseptic, diuretic, ovarian and prostatic inflammations, pains, bloodshed, itching, burning, gastritis, fracture, inflammation, analgesic, anti-pyretic, cancer, hepatoprotective, ulcers, skin infections, purgative backache, hemorrhage, rash, toothache, and menstrual colic (Queiroz Monte *et al.,* 2012). The parts used are bark and leaves. Moreover, the forms used were infusion, decoction, tincture, syrup, and cataplasm (Gaichu *et al.,* 2017a), and (Nkafamiya and Shagal, 2019).

In fact, the phytochemical agents in medicinal plants work together with nutrients found in vegetables, fruits and nuts might even slow the aging process, prevent the risk of or cure many diseases such as heart diseases, diabetics, high blood pressure, cancer, tuberculosis, cataracts and urinary tract infections (Nkafamiya and Shagal, 2019) and (Saleh *et al.,* 2021).

The presence of tannins and flavonoids might support this action, due to their anti-inflammatory properties (Kakou *et al.,* 2020). Direct application of minced leaves or an infusion of bark and leaves used as an antidote in the case of snake and scorpion bites in different tropical countries (Urso *et al.,* 2013). The medicinal use was explain to the presence of chemical compounds such as alkaloids, glycosides, phenols, tannins, saponins and volatile oils.

The chemical profile of *Ximenia caffra* leaf comprehensively analyzed and led to the identification of 10 polyphenol compounds, including phenolic acid and flavonoids. The individual polyphenols were successfully quantitated using UV detection. Further bioactivity investigations showed that the extracts of *X. caffra* leaf exhibit antioxidant, antiproliferation, and anti-inflammatory activities. The underlying molecular mechanism may partially be contributed by the inhibition of NF- kB activation, a shared signal pathway between proliferation and inflammation (Zhen *et al.,* 2015).

Materials and Methods

The fruits and aerial parts of *X. americana* were collected randomly from surrounded area of Nertete

a part of Jabal Mara, Central Darfur State. The leaves washed thoroughly with water and then air dried at room temperature in the Laboratory. The dried leaves made into powder form using a clean mortar and pestle. The leaves were air dried at room temperature, crushed and then subjected to hydro distillation through a conventional Clevenger-type apparatus for 2 h.

Dried leaves were soaked in 70% alcohol for 24 hours, and used to take freehand sections, cleared with chloral hydrate solution and water, stained with safranin according to the standard prescribed methods.

Powder of the shade-dried leaves used for chemical analysis. Physicochemical standard were determined according to the standard procedures of Indian Pharmacopoeia. Preliminary phytochemical screening of the leaf drug carried out according to the standard methods10&11

Two grams of each extract of the two plants dissolved in 20 ml of their own mother solvents to obtain a stock concentration of 10% (v/v). The obtained extracts subjected to phytochemical screening to determine the secondary metabolites. The phytochemicals screened included the flavonoids, alkaloids, steroids, saponins, reducing sugars and tannins. The chemical and physical properties of *X. americana* seed oil were analyzed according to AOAC (1990). Density was determined picno metrically according to AOAC. Refractive index was determined at 25°C with a Carl Zeiss Abbè refractometer. Viscosity was determined with Brookfield Rheometer, DV-III, PR57429, and USA.

The fruits of *X. americana* were freed from the coating layer for getting the pulp. The pulp dried at room temperature. Seeds obtained by breaking down the fruit into two parts.

A weighted sample of the dry crushed seeds extracted with hot petroleum ether at 40 - 60°C. The solvent in the combined extracts was removed by rotary evaporator to obtain the seed oil.

Results and Discussion

Data present in table (1) revealed that *Ximenia americana* was very rich with some pharmaceutical properties. Physicochemical Analysis ash values used to determine the quality and purity of the crude drugs. Procedure given in Indian Pharmacopoeia used to determine the different ash values such as total ash and acid insoluble ash. Alcohol soluble and water-soluble extractive value were also determined as per procedure given in Indian Pharmacopoeia. *Ximenia americana* is one of the most valuable wild edible plants in the world. In different countries, it utilized as food, medicine, an essential oil source, and the industrial component to other products (Kefelegn and Desta, 2021). The aqueous fraction and ethanolic extract caused significant inhibition at the late phase(73.68% and 82.40%, respectively). These results demonstrate that *Ximenia americana* extract, fractions and XM-Catechin produce antinociceptive and anti-inflammatory responses (Dias *et al.,* 2018). The crude extracts of *X. americana* show antimicrobial and antifungal activities. The crude aqueous and methanolic extracts from different parts (leaves, root, stem and stem bark) of the plant were subjected to phytochemical screening and from the test carried out. It was observed that the secondary metabolites contained were saponins, flavonoids, tannins, terpenoids, sterols, quinones, alkaloids, cyanogenetic glycosides, cardiac glycosides and carbohydrates in the form of sugars and soluble starch (Queiroz Monte *et al.,* 2012) and (Maikai *et al.,* 2010).

Preliminary Phytochemical Analysis (Table 1) the dried powder leaf material was extracted with methanol, ethanol and aqueous successively in a Soxhlet apparatus. The extracts filtered while hot and concentrated under reduced pressure. The particle and percentage yields of the extracts were calculated. The concentrated extracts of the leaves subjected to qualitative chemical test for the identification of various active Constituents. The investigation revealed the presence of Alkaloids, Steroids, Sugars, Saponins, Tannins, and Terpenoids

in methanol extract. Steroids in traces, absence of Terpenoids in ethanol and aqueous extract. The previous results are same with the finding of (Kawo, 2011) who said alkaloids and anthraquinones were not present in the extracts. In *X. americana*, flavonoids, steroids, tannins and reducing sugars were found in the methanolic extract while the aqueous extract revealed the presence of alkaloids, saponins and tannins. This use could explained with the presence of chemical compounds such as alkaloids, glycosides, phenols, tannins, saponins (Shantha *et al.,* 2012) and volatile oil. The qualitative phytochemical analysis showed a broad spectrum of bioactive compounds such as alkaloids, terpenoids, flavonoids, phenols, tannins, and glycosides. Similar observation on phytochemical screening showed presence of alkaloids, flavonoids, saponins, cardiac glycosides, phenolic and terpenoids in the extract (Gaichu *et al.,* 2017a) and (Okhale *et al.,* 2017). It found that the aqueous crude extract contains 23.0090 ± 0.04129 mg of phenol and 53.47 ± 0.88059 mg of flavonoids content (Mane and Vedamurthy, 2020). Qualitative phytochemical screening showed presence of alkaloids, flavonoids, saponins, cardiac glycosides, phenolic and terpenoids in the extract (Gaichu *et al.,* 2017a). The antimicrobial activity tests of the plant extracts on *Escherichia coli*, *Staphylococcus aureus*, Salmonella spp and *Candida albicans* showed that ethanol extracts had inhibitory activity on *S. arueus* only. Water extract showed inhibitory activity on *E. coli* and *S. aureus* but did not inhibit the growth of *Candida albicans* and Salmonella spp (Shagal *et al.,* 2013). Phytochemical screening of the methanolic and aqueous extract of the bark showed that they both had flavonoids, anthraquinone, saponins, terpenes and tannin. The aqueous and methanolic extract appears to show some potential activity against *T. congolense* (Length, 2008).

It has reported that roots used in treatment of leprosy, syphilis, dysentery, and wounds (Maikai, n.d.). The root has been cited as a remedy used for hepatic, respiratory, circulatory, urinary and digestive disorders as well as having analgesic, anti-inflammatory, anti- tumor anti-depressive and wound-healing properties (Queiroz Monte *et al.,* 2012). The root extracts have significantly ($p<0.05$) higher content of all phytochemical constituents determined (James *et al.,* 2008). In recent study, results confirm that aqueous extract exhibited high antioxidant activity and flavonoids content.

In MTT assay it shown significant anti-proliferative activity against both non-small cell lung cancer cell lines (Cancer, 2018). Studies with extracts obtained from *X. americana* reveal that this species has an inhibitory capacity over bacterial growth (Rose *et al.,* 2019).

The physical and chemical properties of the oil of *X. americana* are shown in Table 2. The oil recovered from 589.75 gm of seeds of *X. americana* is 302.77 gm which is equivalent to Yield 51.34% oil content on seed weight basis. The oil was yellow in color, odorless and tasteless liquid. The viscosity data of *X. americana* seeds oil are given in Figure 1.

The viscosity of the oil and its temperature dependence in the range 25 - 70°C suggested a potential industrial application of the oil as lubricating base stock. At 70°C, the reduction in viscosity of the oil marked by over 80% of its value at 25°C (Saeed and Bashier, 2010). Thus, judging from the IV of the oil from *Ximenia americana* and its yield, the seed appears to be a viable source of oil for paint formulation. In addition, since the whole seed is edible, the oil may be a good source of poly unsaturated for human nutrition (da Silva *et al.,* 2016). Fresh seeds of *Ximenia americana* presented high levels of protein and oil. *Ximenia americana* oil is a potential economic resource for local communities and could provide important opportunities in increasing family income (Uchôa *et al.,* 2016).

The dominant unsaturated fatty acid found in red *X. americana* flesh was oleic acid (26.29%), and the main saturated fatty acid detected was palmitic acid (29.78%) Figure 2. The seed also had high un-saturated fatty acid which was elaidic acid, (84.32%) (Mamo *et al.,* 2021).

Table.1 Metabolic compounds identified in the phytochemical characterization of *X. americana* (XaAE) aqueous extract.

Constituent	Leave Extract			Stem Bark Extract			Root Extract		
	Methanol	Ethanol	Water	Methanol	Ethanol	Water	Methanol	Ethanol	Water
Alkaloids	-	-	-	+	+	+	-	-	-
Glycosides	-	-	-	+	+	-	-	-	-
Cardiac	-	+	+	+	+	-	-	-	-
Flavonoids	+	+	+	+	+	+	-	-	-
Saponins	-	+	+	+	+	+	+	-	-
Steroids		-	-	-	+	-	+	-	-
Tannins	+	+	+	+	+	+	-	-	-
Quinones	-	-	+	+	+	-	-	-	-
Terpenes	+	+	-	+	+	+			

+: present; -: absent

Table.2 *X. americana* seeds oil properties.

Item	Description
Color	Yellow
Odor	Odorless
Taste	Tasteless liquid
State	Liquid
Solubility	Freely soluble
Boiling Point	157°C
Density	0.9376 g/ml
Viscosity 25°C	227.58
Viscosity 70°C	42.0
Refractive index	1.4770
Acid Value	0.2805
Ester Value	9.82
Iodine Value	47.59
Peroxide Value	30
Saponification Value	11.43
Ratio Value	35009

Fig.1 Physicochemical properties of the oil extracted from *X. americana* pulp and seed.

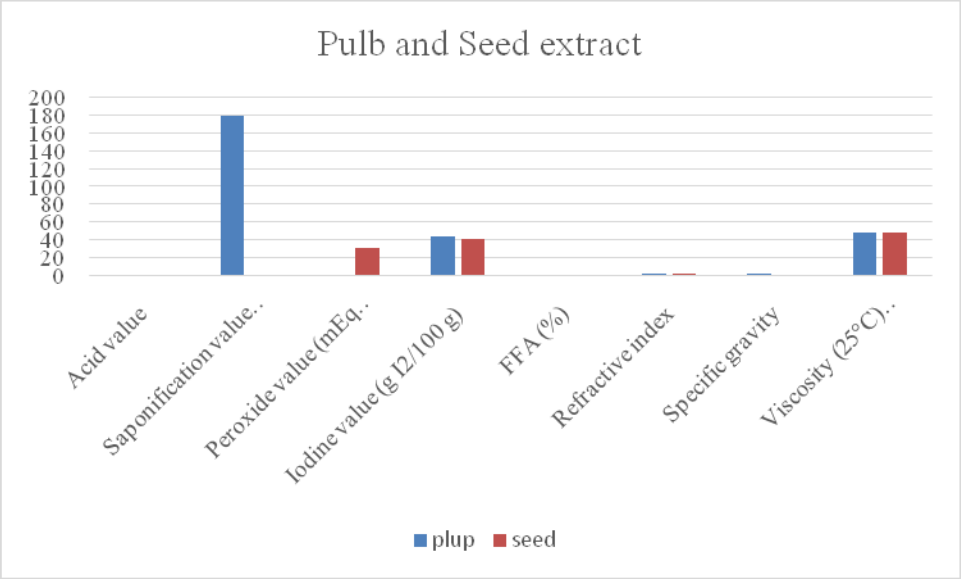
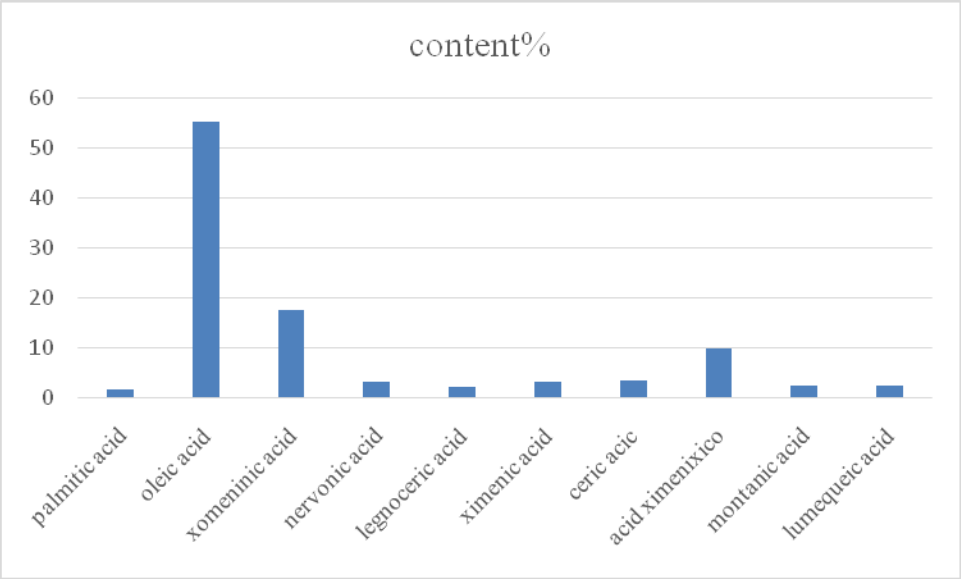


Fig.2 Fatty acid identification



Ximenia americana fruits, stem bark, roots and leaves possess antimicrobial activity. This can explain the rationale for the use of the plant in treating infections in traditional medicine.

The plant could be a veritable and cheaper substitute for conventional drugs since the plant is easily obtainable and the extract can made via a simple process of maceration or infusion. In spite of the multipurpose use of *X. americana* it is locally vulnerable from a number of resource degradation factors.

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How to cite this article:

Taha Mohammed Sharief, Rahma Salaman Mohammed Bashier and Mohammed Ishag Haroon. 2022. Phytochemical Evaluation and Uses of *Ximenia Americana* L in Central Darfur. *Int.J.Curr.Microbiol.App.Sci*. 11(02): 353-360. doi: https://doi.org/10.20546/ijcmas.2022.1102.040