

## Genus *Detarium*: Ethnomedicinal, phytochemical and pharmacological profile

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### Abstract

The genus *Detarium* (Fabaceae, Sub family Caesalpinaceae) is indigenous to Africa. In west Africa the genus is represented by 8 species, however only 3 species *D. macrocarpum*, *D. microcarpum* and *D. senegalense* are of ethnomedicinal and pharmacological interest. These three species are morphologically similar, but tend to vary in regional distribution. *Detarium* species are widely and commonly used in traditional medicine in the treatment of diverse ailments, including, fever, malaria, bronchitis, convulsions, diabetes, microbial infections, etc. Some pharmacological studies have been carried out to authenticate some of these claims. Phytoconstituents with biological activities have been isolated from the genus. Among the identified compounds include, flavones, polysaccharides, clerodane diterpenes, dihydroclerodane diterpenes, tetranoditerpenes, anthocyanidin alkaloids, as well as other secondary metabolites. This paper reviews the comprehensive information on the ethnomedicinal uses, phytochemical profile and pharmacological activities of the genus *Detarium*.

**Keywords:** *Detarium*, Folkloric uses; phytochemistry; biological activities

### Introduction

The genus *Detarium* (Fabaceae, Sub family. Caesalpinaceae) is a native of Africa. It belongs to the tribe Detarieae. It comprises three important species. *Detarium microcarpum* Guill & Perr, *Detarium senegalense* J.F. Gmelin and *Detarium macrocarpum* Harms. These three species are very similar morphologically but appear to differ in ecological distribution. *D. microcarpum* is a small tree up to 10 m tall, with horizontal root system. It is confined to drier regions of west and central Africa. It is typically a specie of dry savanna (Leung *et al.*,1968). Different parts of the plant have been reported to possess medicinal activities (Abreu *et al.*, 1998, Kouyate 2005, Okolo *et al.*, 2012). Among the Ibo tribe of south eastern Nigeria, the plant known as “Ofo” is believed to be a “religious” tree which

grows in God's own compound, symbolizing truth and honesty (Ejizu, 1986). It is the most investigated species of the genus because of its popular use in African traditional medicine.

*D. senegalense*, J.F. Gmelin is a native of tropical Africa, found close to river bank. It occurs from Senegal and the Gambia east to Sudan, and south to northern Democratic Republic of Congo. It is planted as fruit tree and as ornamental shade tree. It may grow up to 38 m high with highly buttressed bole. It is commonly known as tallow tree. It is widely in herbal medicine in Nigeria. It has a considerable commercial in food and pharmaceutical industries (Wang et al., 1996). *D. macrocarpum* occurs in the humid forest of tropical Africa. It has similar characteristic as *D. microcarpum*.

### **Ethnomedicinal uses**

The genus *Detarium* especially *D. microcarpum* and *D. senegalense* are widely applied in traditional folk medicine throughout their areas of distribution. In the eastern part of Nigeria, they are revered plants, mythically believed to be chip of the primal trees that germinate and grow in God's own garden. They are the main object in traditional worship, symbolizing truth, honesty and integrity (Ejizu, 1986).

Throughout western Africa the genus *Detarium* is believed to possess medicomagical powers. In African ethnomedicine, they are used in the treatment of diverse diseases, notably, syphilis, dysentery, diarrhea, bronchitis, pneumonia, sore throat, malaria, leprosy and meningitis (Dalziel 1937, Abreu et al., 1995, 1999, Kaey et al., 1989, Burkell 1995), (Table 1). In Burkina Faso, the fruit pulp of *D. microcarpum* is used to treat skin infection. In Mali the bark is used to treat measles, itching, hypertension, nocturia and tiredness, while the decoction of the leaves or roots is used for paralysis, meningitis, tiredness, cramps and difficult delivery (Kouyate 2005).

In Niger and Togo, the fruit preparation is used for dizziness, while in Benin a decoction of the leaves is used in treating convulsions and fainting. Apart from medicinal uses, the fruit of *D. microcarpum* is sweet and commonly eaten fresh, while the pulp is used in making cakes, as well as a substitute for sugar. The seeds are used as frankincense to ward off evil spirits,

The ethnomedicinal uses of *D. senegalense* are very much similar to those of *D. microcarpum*. (Table 1). It is an important medicinal plant. Different parts are extensively used in traditional medicine. The fruit pulp is reported to be useful for kidney pain, spinal tuberculosis, syphilis, cough, rheumatism and used to treat fever (Kaey et al., 1998). The leaf and shoot decoctions are used for dysentery, anaemia, conjunctivitis inflammation and skin complaints (Burkill 1995). The bark appears to be the most widely used part in traditional medicine. The bark powder is applied to treat wounds, burns and skin problems (Burkill 1995). Also the bark decoctions are claimed to be effective in cases of heavy blood lost, bronchitis, pneumonia, stomach ache, digestive disorders, and in expelling the placenta after childbirth. The seeds are taken as antidote against arrow poison and snake bite. The roots are used for convulsions (Kaey et al., 1989).

Table 1: Ethnomedicinal uses of the genus *Detarium*.

Botanical name	Part used	Folk medicinal uses
<i>Detarium microcarpum</i> Guill. & Perr.	Leaves, bark and roots as infusions or decoctions	Rheumatism, venereal disease, urogenital infections, haemorrhoids, caries, biliousness, stomach-ache, intestinal worms and diarrhoea, dysentery, malaria, leprosy and impotence (Kouyaté and van Damme, 2006).
	Powdered bark decoction	Headache, sore throat, back pain, painful menstruation, measles, nocturia, hypertension, itch, and tiredness (Kouyaté and van Damme, 2006).
	Decoction of leaves or roots	Paralysis, meningitis, tiredness, cramps, and difficult delivery. Fainting and convulsion (leaves only). Diarrhoea and constipation in cattle. (Kouyaté and van Damme, 2006).
	Leaves smoke (inhalation)	Fever in cattle (Kouyaté and van Damme, 2006).
	Powdered seeds	Skin infections and inflammations (Kouyaté and van Damme, 2006).
	Fruits eaten	Skin infection and malaria (Kouyaté and van Damme, 2006).
	Fruit pulp	Skin infections (Kouyaté and van Damme, 2006)
<i>Detarium senegalensis</i> J.F Gmel.	Stem barks, seeds, leaves and root decoctions or infusions	Veneral diseases, urogenital infections, hemorrhoids, rheumatism, stomach-ache, intestinal worms, diarrhoea, malaria and leprosy (Abreu et al., 1998, 1999; Kaey et al., 1989).
	Powdered bark decoction	Pain alleviation such as head-ache, back pain, sore throat, and painful menstruation (Abreu et al., 1998, 1999; Kaey et al., 1989).
	Stem bark macerated in palm wine	Bronchitis, pneumonia and leprosy (Burkil, 1995).
	Pulp from bark	Remedy for tuberculosis (Okwu and Uchegbu, 2009).
	Bark decoction	Placenta expellant (Kaey et al., 1989).
	Liquid from boiled bark	Indigestion (Kaey et al., 1989).
	Leaves decoction	Convulsion (Kaey et al., 1989).
	Roots	Part of medico magical treatment for mental conditions and for protection against evil spirits (Dalziel, 1995).
	Roots and leaves	Diarrhoea in cattle (Kaey et al., 1989).
	Stem bark	Measles, hypertension, itch and tiredness (Kaey et al., 1989).
	Decoctions of root and leaves	Paralysis, meningitis and difficult delivery (Kaey et al., 1989).
Stem bark, seeds, and leaves. Infusion and decoction	Veneral disease, urogenital infections, intestinal worms. (Abreu and Relva, 2002)	

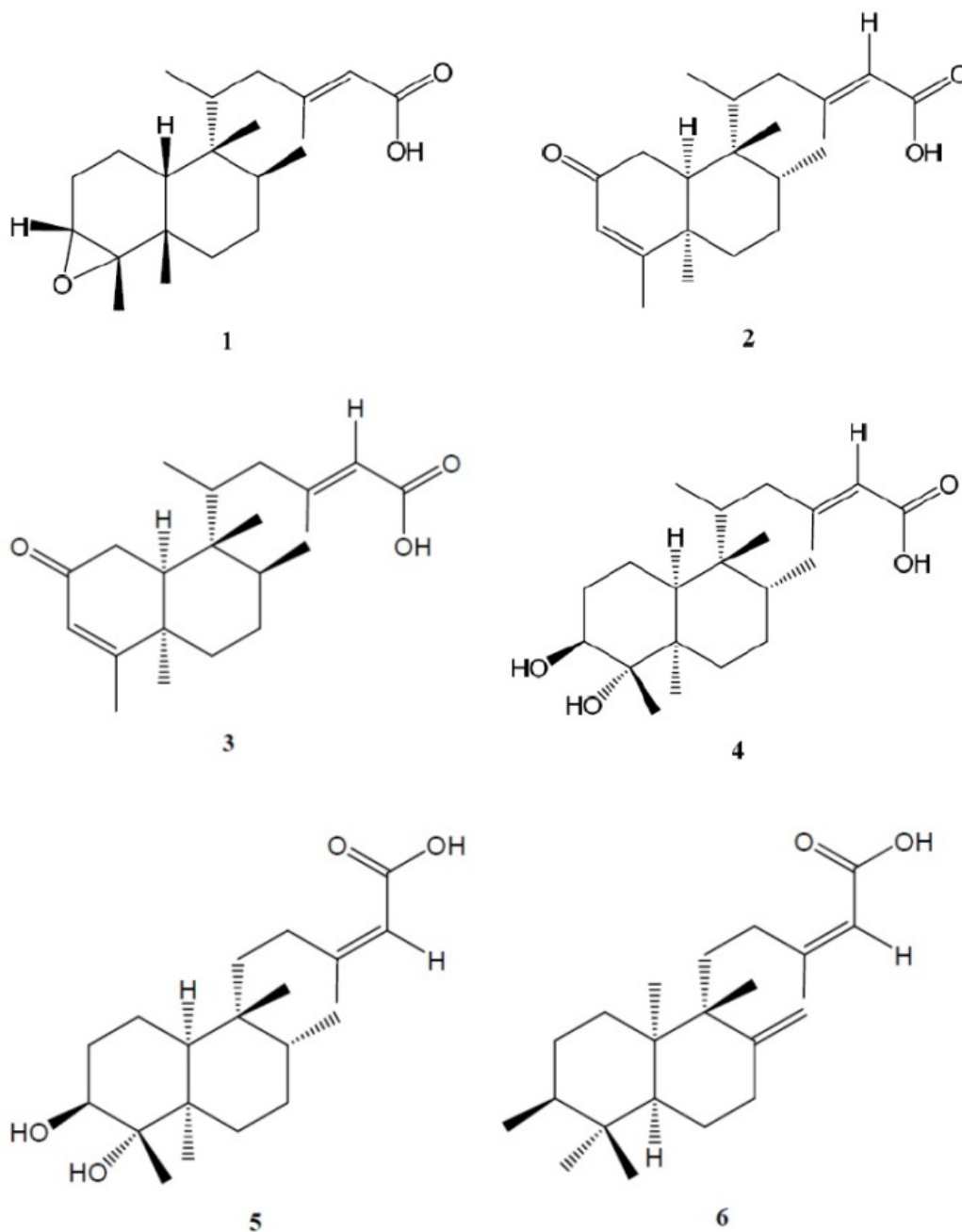
## Phytochemical Profile

The commonly known phytochemical compounds in the genus *Detarium* are flavanes (Mahmood *et al.*, 1993). A wide range of chemical constituents have been isolated from the genus *Detarium*. These include diterpenes (Wating and Guinko, 1998) and water soluble polysaccharides, proteins and coumarins (Neuwirger, 1996). Xyloglucan was identified as the main water soluble non-starch polysaccharide in the genus (Onyechi *et al.*, 1998).

Table 2. Some phytochemical constituents of *Detarium* species.

Plant	Compound	Plant part	Reference
<i>Detarium microcarpum</i>	1. Clerodane diterpenes e.g. i) 3, 4- epoxyclerodan-13E-en-15-oic acid(1), ii) 5 $\alpha$ , 8- $\alpha$ (2-oxokolavenic acid (2) iii) 3, 4-dihydroxyclerodan-13E-en 15-oic acid(4) iv) 3, 4-dihydroclerodan-13z-en-15-oic acid (5) v) 2-oxokolavenic acid (3) Copalic acid (6)	Fruit pulp	Cavin <i>et al.</i> , 2006
	2. Sitosterol, lupol, $\beta$ -sitosterol, stigmasterol, campesterol	Bark extract	Abreu <i>et al.</i> , 1998
	3. $\gamma$ -quinide, (-)-bomesitol, D-pinitol, myoinositol, sucrose, D-glucose, D-fructose	Bark extract	Abreu and Relva 2002
	Saponins Proteins Carbohydrates Reducing sugar Resins Flavonoids Glycosides Terpenoids Steroids Fats and Oil	Root extract	Okolo <i>et al.</i> , 2012
<i>Detarium senegalensis</i>	2-methoxyamine 3,4,5,7-tetrahydroxy anthocyanidines	Stem bark	Okwu and Uchegbu, 2009
	Cyclohexanone $\beta$ -myrcene Cis-Rose oxide Camphor Citronellol E-citral Isolatedene Palmitic acid Linoleic acid Oleic acid	Seed extract	Sowemimo <i>et al.</i> , 2011

From the CH<sub>2</sub>Cl<sub>2</sub> extract of the fruit pulp of *D. microcarpum*, Cavin *et al.*, (2006) isolated 4 clerodane diterpenes 3,4-epoxy cherodan-13E-en-15-oic acid, 5 $\alpha$ ,8 $\alpha$ -(2-oxokolavenic acid, 3,4-dihydroxyclerodan-13Z-en-15-oic acid, as well as 2-oxokolavenic acid and co-palic acid (Fig.1)



- 1. 3, 4- epoxyclerodan-13E-en-15-oic acid,
- 3. oxokolavenic acid
- 5. 3, 4-dihydroclerodan-13z-en-15-oic acid

- 2. 5 $\alpha$ , 8 $\alpha$  (2-oxokolavenic acid
- 4. 3, 4-dihydroxyclerodan-13E-en-15-oic acid
- 6. Copalic acid

Fig. 1: Some phytoconstituents isolated from the fruit pulp of *D. microcarpum* (Cavin *et al.*, 2006).

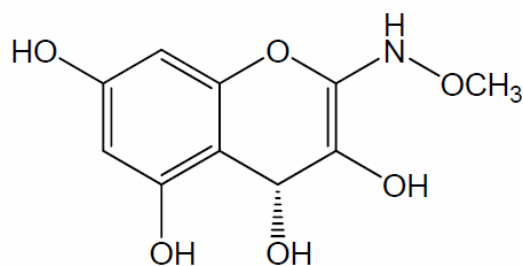


Fig. 2. Isolated anthocyanidin alkaloid from the seed of *D. senegalense* (Okwu and Uchegbu, 2009)

From the bark extract of *D. microcarpum* Mahmood *et al.*, (1993) isolated two tetra-norditerpenes-the derodane diterpenes catechine and cis-2- oxokolavenic acid, as well as the diterpene copalic acid and coumarins. Also from the bark extract, Abreu *et al.* (1998) isolated sitosterol,  $\beta$ -sitosterol, lupol, stigmasterol and campesterol, while Abreu and Relva (2002) identified  $\gamma$ -quinide, (-)-bomesitol, D-pinitol, myoinositol, sucrose, D-glucose and D-fructose. The seed gum was reported to contain D-galactose as a major monosaccharide, as well as D-mannose and D-glucose (Onweluzo *et al.*, 1999).

Phytochemical analysis of petroleum ether extract of the seeds of *D. senegalense* revealed 10 constituents with oleic and linoleic acids being most abundant (Sowemimo *et al.*, 2011). An anthocyanidin alkaloid-(2-methoxyamine-3,4,5,7-tetrahydroxy anthocyanidines was isolated from the stem bark of the plant Okwu and Uchegbu 2009), (Fig. 2)

### Pharmacological activities

Members of the genus *Detarium* have been subjected to some scientific investigations with the aim of ascertaining some of the folkloric claims ascribed to them. Some of the reported activities include:

#### *Antidiabetic activity*

The water soluble non-starch polysaccharides obtained from the seeds of *D. senegalense* were shown to reduce postprandial blood glucose and insulin concentrations in human (Onyechi *et al.*, 1998). Studies with the seed extract of *D. senegalense* (Odoh *et al.*, 2008) indicated a significant reductions in blood sugar level and blood lipid levels. The extract did not affect the haematological parameters and serum chemistry, a reflection of the safety of the seed extract.

Recently, Okolo *et al.* (2012) reported that methanol extract of *D. microcarpum* roots and its fraction significantly reduced blood sugar level in alloxan-diabetic rats without producing hypoglycemia, an effect attributed to the flavonoids abundantly present in the extract.

#### *Antibacterial and antifungal activities*

Most of the work done on this genus appear to be on antimicrobial activities. The ethanol extract of the bark of *D. microcarpum* was shown to exhibit antimicrobial action against some pathogenic organisms including *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Cit-*

*robacter freunditis Staphylococcus. aureus, Streptococcus pyrogenes* and *Listeria monocytogenens*. (Abreu *et al.*,1998). In a study using the aqueous methanol extract of the seeds of *D. microcarpum* (Ebi and Afiero, 2011), a broad spectrum antimicrobial activity was observed against clinical isolates of *Staphylococcus, aureus, Bacillus subtilis, Escherichia. coli, Pseudomonas aeruginosa,,Klebsiella.pneumonia, Salmonena. paratyphi* and *Candida albicans*.The authors attributed this activity to the presence of steroidal saponins and flavonoids.

Similarly, Sowemimo *et al.*, (2011) reported a broad spectrum antibacterial and antifungal activity for the petroleum ether extract of the seeds of *D. senegalense*. The result indicated that the oil from the seed ;inhibited most of the Gram-positive bacteria except *Bacillus cereus* and three Gram-negative bacteria except *Escherichia. coli* and *Pseudomonas aeruginosa*. The oil also showed antifungal activity against *Aspergillus flavus, A. niger* and *Penicillium notatum* (Sowemimo *et al.*, 2011). Okwu and Uchegbu (2009) isolated anthocyanidin alkaloids from the ethanol stem extract of *D. senegalense* that exhibited strong antibacterial activity against *Staphylococcus. aureus, Escherichia coli, Pseudomonas. aeruginosa, Proteus mirabilis* and *Klebsieila pneumonia*. Inhibition of the growth of the plant pathogenic fungus-*Cledosporium eucumerinum* by the pulp extract of *D. microcanpum* was reported by Cavin *et al.* (2006). All these studies taken together, point to the potential antimicrobial usefulness of *Detarium* species.

### **Antiviral activity**

The flavanes present in the methanol extract of *D. microcarpum* was shown by Mahmood *et al.* (1993) to strongly inhibit HIV-1 or HIV-2 virus. Olugbuyiro *et al.* (2009) reported the antiviral activity of the fractions of the methanol stem bark extract of *D. microcarpum* using using-7 Replicon assay. They demonstrated that the active fraction MTH-1700 selectively inhibited Hepatitis C-Virus (HCV). Similar activity has been reported for; *D. senegalense* (Kudi and Myint 1999). The extract was also shown to exhibit moderate antitumor activity against breast cancer (Abreu *et al.*, 1999). Also the bark extract of *D. microcarpum* showed significant molluscicidal activity against *Lymnaea natalensis* (Mahmood *et al.*, 1993)

### **Enzyme Inhibition**

The clerodane diterpenes isolated from the fruits of *D. microcarpum* (Cavin *et al.*, 2006) was shown to inhibit the enzyme acetylcholinesterase (AChE). One of the compounds-5 $\alpha$ ,8 $\alpha$  (2-oxokolavenic acid was ten times as potent as galanthamine, a clinically useful drug for Alzheimer's disease. Inhibition of AChE is currently the most efficient approach in managing the symptoms of Alzheimer's disease.

### **Antisnake venom activity**

The leaves of *D. microcarpum* is commonly used in the northern part of Nigeria to treat snake bite. Studies by Iful (2008) reported that the leaf extract of *D. microcarpum* potently reduced mortality in *Echis carinatus* (carpet viper) venom treated animals. The study also revealed that the extract relaxed the rabbit isolated jejunum and contracted the rat phrenic-nerve-diaphragm muscle.

## Future perspectives and predictions

Clerodane diterpenoids are reported to be a part of secondary metabolites found in various species of genus *Detarium*. According to structural similarities of reported clerodane diterpenoids, there is strong possibility that Clerodane diterpenoids is involved in various pharmacological activities that have been reported for the crude extract of *Detarium* genus and as isolated molecule. These include antidiabetic properties (Onyechi *et al.*, 1998; Odoh *et al.*, 2008, Okolo et al, 2012), antibacterial and anti-fungal activities (Abreu *et al.*, 1998; Ebi and Afieroho, 2011), antiviral activities (Mohmood *et al.*, 1993; Abreu *et al.*, 1999; Olugbuyiro *et al.*, 2009), enzyme inhibition (Cavin *et al.*, 2006), and anti-snake venom activities (Iful, 2008). Apart from ethnopharmacological relevance, new pharmacological applications of the species of genus *Detarium* can be explored based on molecular structural similarities. In this persepective, new and better lead compounds or analogues can be discovered.

## Conclusion

This review reveals the recent studies on the genus *Detarium*. There is extensive use of the genus in traditional medicine for a variety of ailments. Studies have shown the potentials of the genus as an anti-diabetic, anti-microbial, anti-cancer, anti-Alzheimer and ant-snake venom agent. The possibility of developing a novel therapeutic molecule from the genus is high.

## Conflict of interest

There is no conflict of interest associated with the authors of this paper.

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