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Review

Cassia abbreviata Oliv. A review of its ethnomedicinal uses, toxicology, phytochemistry, possible propagation techniques and Pharmacology

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A variety of ethnotherapeutic properties and pharmacological actions has been attributed to *Cassia abbreviata* Oliv. which belong to the family Caesalpiniaceae. Reports from the literature have indicated the presence of a variety of compounds including alkaloids. Studies by various groups of investigators revealed that *C. abbreviata* possess antidiabetic, antioxidant and antimicrobial activity, thus lending pharmacological support to the plant's folkloric uses in African indigenous medicine. This review is aimed at collating presently available information on pharmacological, toxicological, propagation techniques, phytochemical ingredients and both ethnomedicinal and other uses of *C. abbreviata*.

Key words: *Cassia abbreviata* Oliv., ethnomedicine, pharmacological properties, toxicity.

INTRODUCTION

Cassia, a major genus of the family Caesalpiniaceae, comprises of about 600 species and is well known for its diverse biological and pharmacological properties (Silva et al., 2005; Ayo, 2010; Chanda et al., 2012; Singh et al., 2013). *Cassia abbreviata* is a shrub which grows up to 10 m in height. It has a light brown bark, rounded crown and yellowish leaves. It has compound leaves, with 5 to 12 pairs, and brown black pods which are cylindrical in shape. Flowers are yellow, sweet-scented, large, loose, becoming brown-veinted with age and fruits are long cylindrical dark brown and hanging pod (Venter and Venter, 2009). It is widespread in Africa, from Somalia to South Africa and occurs mostly at low to medium altitudes (between 220 and 1520 m above sea level), in open bushveld, woodland or wooded grasslands, along rivers, on hillsides and frequently on termite mounds (Coates, 2005). *C. abbreviata* is endangered in the majority of areas and is reported to be in rank 3, score 401 and frequency of 33 of the top 10 priority medicinal trees in Shinyama region, Zambia (Dery et al., 1999). Due to its scarcity in the majority of African countries, there is a need to have a policy in place to reinforce protection measures and promote sustainable use for this plant (Schmelzer, 2010). However, its ethnomedicinal uses are also of major importance, especially in remote areas where traditional medicine serve as basic primary healthcare, compromising the rational use of resources.

In some tribes within the Capricorn District, South Africa, *C. abbreviata* bark is used in the doctoring of homesteads on annual basis. Such plants grow in clusters or multiple stems (Figure 1) which are believed to resemble architecture of cultural mud-made huts. This

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Figure 1. Multiple stems of *Cassia abbreviata* Oliv.

review highlights the phytochemical constituents, pharmacology, indigenous ethnbotanical uses, propagation procedures and toxicity of *C. abreviata* Oliv.

ETHNOBOTANICAL USES

Roots

In South Africa and Botswana, amongst variety of tribes, *C. abbreviata* is known as “Monepenepe”. The root is ground into powder, mixed with water and used to wash dirty blood, referring to a woman who has miscarried and need to be cleansed (Setshogo and Mbereki, 2011). In Tanzania, it is commonly known as “Mahemba” and decoction of the root is drunk against abdominal pains, dysentery, fever, malaria, hernia, wounds, syphilis, impotency and snake bite (Chhabra et al., 1987; Muthaura et al., 2007; Makundi et al., 2006). In Mozambique, it is called “Lumanyama” and a decoction of root bark may be taken orally to treat diarrhea (Ribeiro et al., 2010). Root bark may be optionally combined with those of *Cissampelos mucronata* (“Makuta gambewa”) to treat malaria (Gessler et al., 1995). It is an aphrodisiac and is an arbotifacient (van Wyk and Gericke, 2007). In Zimbabwe, *C. abbreviata* is commonly known as “Muremberembe” and the roots may be crushed, mixed with hot water and the extract may be drunk to treat disorders like constipation, diarrhoea, venereal diseases and as an aphrodisiac (Maroyi, 2013) while the bark may be soaked into water and the resulting liquid may be taken by mouth for two days to treat abdominal pains (Chinemana et al., 1985).

Stem bark

Decoction of stem bark is taken orally to treat stomach ache and malaria, while infusion of roots, leaves and stem bark mixed together is taken orally to treat stomach ache (Ribeiro et al., 2010). Bark and roots may also be used to treat stomach ache of a mother during pregnancy, close fontanelle of newborn babies, dysentery, blood vomits, venereal diseases, bilharzia, hernia, snake bites, post-partum pains and menstrual cycle problems (Bruschi et al., 2011). Moreover, bark and

roots may be used as general blood cleansers and in the treatment of period, uterus and abdominal pains (Mojeremane et al., 2005).

Leaves

In Kenya, *C. abbreviata* is known as “Malandesi” and leaf decoction may be taken to treat malaria (Keter and Mutiso, 2012). It may also be used to treat skin rashes associated with human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) infections (Kisangau et al., 2011). Roots, leaves and bark may be taken orally, chewed, nasally and anally to treat infertility, cough, vomiting, epilepsy, bilharzia, syphilis, gonorrhoea, jaundice and hernia (Augustino et al., 2011).

Fruits

Decoction may be taken to treat malaria (Keter and Mutiso, 2012), while heating and grinding may be used to wash infected eyes (Ribeiro et al., 2010).

Other uses

C. abbreviata may be used as fuelwood, timber, furniture making, and construction and has ornamental value (Dharani et al., 2010).

PHYTOCHEMISTRY

Anthocyanins, anthranoids, anthraquinones, polyphenols and tannins have been characterized from root ethanol extract (Leteane et al., 2012). Leaves and twigs extracted with dichloromethane yielded 2,4-trans-7, 4’-dihydroxy-4-methoxyflavan (Dehmlow et al., 1998) while acetone extract of the stem bark yielded compounds such as guibourtinidol-(4β→8)-epiafzelechin, guibourtinidol-(4α→8)-catechin, guibourtinidol-(4β→8)-epicachetin and ent-guibourtinidol-(4β→8)-epicachetin (Malan et al.,1996). Recently, two novel trimmeric proanthocyanidins such as 3,7,4´-trihydroxyflavan-(4β→8)-3,5,7,4´-tetrahydroxyflavan-(3´→6)-3,5,7,2´4´-pentahydroxyflavan (Cassinidin A) and 3,7,2´,4´-tetrahydroxyflavan-(4α-8)-3,5,7,4´-tetrahydroxyflavan–(4α→6) 3,5,7,2´,4´-pentahydroxyflavan (Cassinidin B) have been isolated from root bark of this plant (Figure 2) (Erasto and Majinda, 2011). Moreover, two flavans, 2,3-dihydro-5-hyrdoxy-8-methoxy-2-(4-methoxyphenyl) chromen-4-one and 3,4-dihydro-2-(4-hydroxyphenyl)-4-methoxy-2H-chromen-7-ol which resemble that of 2,4-trans-7, 4’-dihydroxy-4-methoxyflavan isolated from leaves and twigs earlier (Kiplagat et al., 2012).

PHARMACOLOGICAL ACTIVITIES

Antibacterial and antifungal activity

Khan (2001) investigated antibacterial activity of petrol, ether and chloroform fractions of the root extract against *Staphylococus aureus*. Each solvent was tested at its acidic, basic and neutral components at a concentration of 0.5 mg/disc. The basic fraction of root ether extract exhibited a zone of inhibition ranging from 15 to 20 mm. Fractions of petrol and chloroform extracts were inactive against the selected bacterial strain. Kambizi and Afolayan (2001) studied methanol, acetone and water extracts of the stem bark against a variety of bacterial strains. Both acetone and methanol extracts exhibited minimal inhibitory concentration (MIC) of 0.5 mg/ml, against *Bacillus pumilus*, *Bacillus subtilis*, *Micrococcus kristinae* and *S. aureus,* 1.0 mg/ml against *Bacillus cereus* and 5.0 mg/ml against *Escherichia coli and Proteus vulgaris*. Water extracts showed a MIC value of 1.0 mg/ml against *Bacillus pumilus*, *Micrococcus kristinae* and *S. aureus*, while MIC of 5.0 mg/ml was obtained against *Bacillus subtilis* and *Enterobacter cloacae.* Dry roots extract was reported active against *E. coli* (055) and a clinical isolate of *Neisseria gonorrhoea* (Khan and Nkunya, 1991). Methanol and *n*-hexane extracts showed activity against *S. aureus* and *E. faecalis* (Barata et al., 2007). Elsewhere, aqueous citric acid and methanol fractions were reported active against *S. aureus*, *E. coli* and *Candida albicans* (Zitsanza and Gundidza, 1999).

Methanol extracts of stem bark and roots were reported inactive against *Candidas albicans*, *Candidas glabrata*, *Candidas tropicalis*, *Candidas parapsilosis*, *Candidas krusei* and *Cryptococcus neoformans* (Hamza et al., 2006). Cassinidin A revealed potent MIC of 0.1 µg/ml against *Candida mycoderma* while Cassinidin B exhibited MIC of 5 µg/ml against *B. subtilis* and *S. aureus* (Erasto and Majinda, 2011). Water extracts from stem bark revealed a MIC of 6.25 mg/ml against *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Serratia marscens* and *B. pumilus* while ethyl acetate extracts revealed MIC of 4.17 against *E. coli*, *S. aureus* and *Bacillus cereus* (Mongalo, 2013). Moreover, acetone extracts from the leaf exhibited a MIC of 2.08 mg/ml against clinical isolate of *Shigella flexineri*.

Antimalarial activity

Ethanol leaf extract exhibited promising results with ID_{50} of 111.0 mg/kg/wt against white albino mice (Innocent et al., 2009). Dichloromethane extract of the root exhibited moderate activity with IC_{50} of 40.0 ± 1.8 µg/ml against *Plasmodium falciparum* strain 3D7, while methanol, ethanol and n-hexane equally exhibited IC_{50} > 100 µg/ml against the same strain (Ramalhete et al., 2008). Ethanol

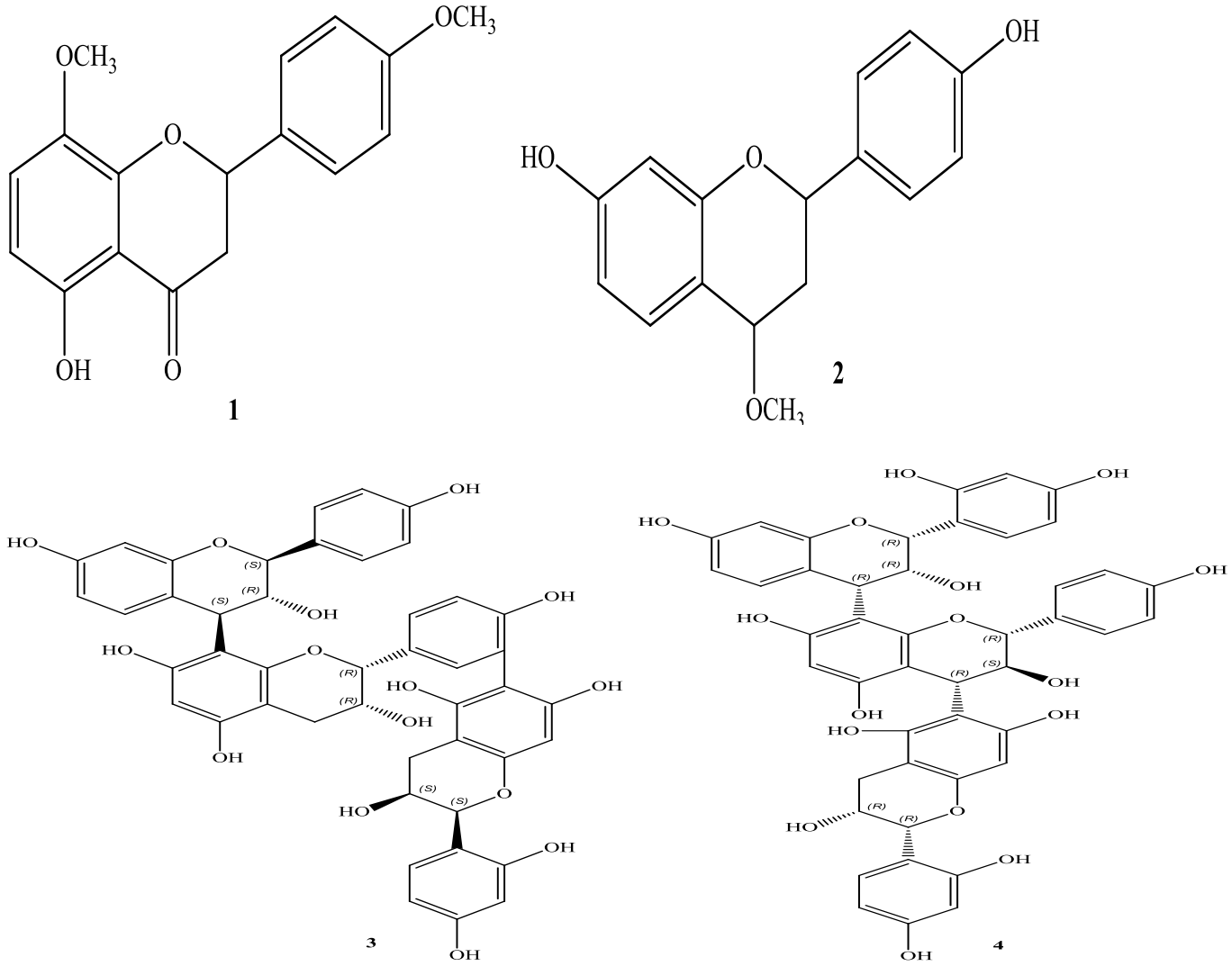

Figure 2. Some individual compounds isolated from *Cassia abbreviate.* **1**: 2,3-dihydro-5-hyrdoxy-8-methoxy-2-(4-methoxyphenyl) chromen-4-one; **2**: 2,4-trans-7, 4'-dihydroxy-4-methoxyflavan; **3**: 3,7,4´-trihydroxyflavan-(4β→8)-3,5,7,4´-tetrahydroxyflavan-(3´→6)-3,5,7,2´4´-pentahydroxyflavan (Cassinidin A)*;* **4**: 3,7,2´,4´-tetrahydroxyflavan-(4α-8)-3,5,7,4´-tetrahydroxyflavan–(4α→6) 3,5,7,2´,4´-pentahydroxyflavan (Cassinidin B).

extract of root has been partitioned and screened for antimalarial activity against *P. falciparum* strain K1. The ethanol fraction possessed relatively good antimalarial activity with IC_{50} of 39 µg/ml compared to ethanol, petroleum ether and water fractions which yielded activities of 85, 160 and 400 µg/ml, respectively (Gessler et al., 1995). Water extract of the root bark showed less activity against *P. falciparum* strains NF54 and ENT30 with IC_{50} of > 200 µg/ml (Rukunga et al., 2009). 2,4-trans-7, 4'-dihydroxy-4-methoxyflavan isolated from root bark of *C. abbreviata* exhibited potent antiplasmodial activity (IC_{50}) of 8.12 and 8.89 µg/ml against Antiplasmodial D6 and Antiplasmodial W2 (Kiplagat et al., 2012).

Anthelmintic activity

Extracts of both leaf and root were investigated for anthelmintic activity by Molgaard et al. (2001). Water extracts of dried leaves produced lethal activity at a concentration of 67.5 mg/ml against cestodes of *Hymenolepis diminuta* worms after 24 h while it had no effect after 1 h. Water extracts of full root exhibited activity of 3.2 mg/ml both after 1 and 24 h. The effect of full root extract was less than 0.2 per logarithmic concentration mg/ml. However, both leaf and full root extracts had no effect on schistosomules of *Schistosoma mansoni* and there was no correlation between results

with cestodes and schistosomules.

Antiviral activity

Ethanol root extract containing tannin and without tannin significantly exhibited antiviral p24 antigen in super-natants of peripheral blood mononuclear cells (PBMCs) infected with HIV-1c (MJ_4) at 55.1 ± 3.1 and 38.5 ± 2.1%, respectively (Leteane et al., 2012). Moreover, from a dose response curve, *C. abbreviata* produced EC_{50} of 102.7 µg/ml and did not block HIV replication.

Antioxidant activity

Methanol extracts from stem bark exhibited IC_{50} of 1.87 ± 0.25 mg/100 ml against 2,2-diphenyl-1-picrylhydrazyl (DPPH) W (Mongalo, 2013). *C. abbreviata* bark exhibited antioxidant activity with IC_{50} of < 7.8 µg/ml against 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid) (ABTS), which was well comparable to positive control, trolox which posessed 11 ± 0.9 µg/ml (Shai et al., 2010). Aqueous extract of stem bark had no antioxidant effects, when incubated with normal human dermal fibroblasts (NHDF) prior to oxidant addition, hence unable to protect cells from damage (Krishnan, 2005).

Antidiabetic activity

At a concentration of 6.4 mg/ml, acetone extracts of stem bark permitted the release of 12% of pNP from pNPG, amounting to 88% inhibition of yeast α-glucosidase activity and IC_{50} equivalent to 0.6 mg/ml (Shai et al., 2010). Simillar extracts exerted an IC_{50} of 0.01 mg/ml against yeast α-glucosidase and a slight inhibition against the mammalian version of α-glucosidase (Shai et al., 2011). Difference in yeast α-glucosidase was due to differences in concentrations of the enzymes.

TOXICOLOGY

Methanol extracts of the root exhibited high toxicity in a brine shrimp lethality test with LC_{50} of 12.7 µg/ml at 95% confidence limit which ranged from 8.1 to 19.8% (Moshi et al., 2007). However, ethanol extracts of the same plant part was found less toxic with an IC_{50} of 39.6 with similar confidence limit ranging from 27.3 to 57.6 (Moshi et al., 2006). Ethanol root extracts did not show cytotoxicity over a concentration range of 0.0001 to 1000 µg/ml using PBMCs as experimental system and exhibited a therapeutic index of > 9.8 (Leteane et al., 2012). Aqueous extracts of stem bark exhibited no toxicity on the growth of the fibrotic model when applied at a dose range of 0.001 to 1000 µg/ml and only exhibited toxicity at 1800 µg/ml (Krishnan, 2005).

PROPAGATION TECHNIQUES

Cultivation by seedlings has been reported (Dharani et al., 2010; Mojeremane et al., 2005). Seeds germinate in 4 to 10 days and pouring of hot water at a temperature of 80°C and allowing to cool overnight improves germination. Seeds should be grown in pots containing 1:1 ratio of sand and compost mixture in a warm and moist nursery conditions. Seedlings need only few months before planting out in a 6 by 6 m spacing in a farmland. Seedlings develop a long taproot, and growth rate may be up to 70 cm per year.

CONCLUSION

C. abbreviata is a medicinal plant possessing medicinal, ornamental and other values. Pharmacologically, it possess antimicrobial, antimalarial, anthelmintic, antioxidant and antidiabetic properties which may well be attributed to variety of compounds including alkaloids, tannins, anthraquinones, flavonoids and polyphenols. Due to its current conservation status in the majority of African countries and increasing life threatening diseases, there is a need to conserve, propagate and re-plant in our natural ecosystems. Reported slow growth of *C. abbreviata*, inceasing human populations and resistance of a variety of infectious microorganisms further alarms a need to consider strict protection of *C. abbreviata* in core conservation areas, with a good cooperation between indigenous traditional herbalists, traditional healers, local governments and conservation biologists in various countries.

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