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Pharmacognostic, Phytochemical and Pharmacological Review of "Phog"- *Calligonum polygonoides L.*

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ABSTRACT

Calligonum polygonoides (Phog) belongs to family Polygonaceae. It is a geographically widely distributed shrub seen from the arctic to the tropics. This endangered plant (included in Red data book of IUCN) is morphologically having stem with nodes and internodes, white flowers in spike inflorescence and needle like leaves. It is traditionally used to stabilize sand dunes, as fuel, and in treatment of heat-stroke by mixing with curd or "Rayata". It is also reported as antidote for opium poisoning. Various phyto-chemicals present include butanolides- calligonolides A and B, various flavanoids like kaempferol, quercetin and their derivatives. Various steroidal compounds are reported in roots. Pharmacologicallly, its cytotoxic, anti-inflammatory, antioxidant, antifungal and biosorbent potentials are reported by various researchers. Therefore, an attempt has been made to accumulate properties of this potential herb.

Keywords: *Calligonum,* phog, biosorbent, heat-stroke, calligonolides, kaempferol

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INTRODUCTION

Calligonum is commonly known as 'Phog' or 'Phogla' in deserts of Rajasthan. Small shrub of "Phog" belongs to family Polygonaceae. It is found in Southern Trans-Indus plains, Baluchistan, Thar and Cholistan desert areas. It is about 1 to 2 m high, with a girth of 30 to 60 cm.[1] It may even grow in adverse conditions of moisture and soil, but grows commonly on dry sandy soils and on sand dunes.[2]

Floral buds are used as vegetable and are consumed with buttermilk and salt. For this purpose, they are picked during February and March.[3,4] It enriches sandy soil with nutrients. It is known to increase the fertility of the soils by alteration of microclimate in soil.[5–7]

TAXONOMIC POSITION

Kingdom	*Plantae*
Order	*Caryophyllales*
Family	*Polygonaceae*
Sub-family	*polygonoideae*
Genus	*Calligonum*
Species	*polygonoides*

Figure 1: Habitat *of C. polygonoides*

Figure 2*: Calligonum polygonoides* Linn.- flowering plant & dried flower buds

DISTRIBUTION

It is a geographically widely distributed shrub seen from the arctic to the tropics. Major concentrations are gained in Northern temperate region by most of the species (Heywood, 1978). Worldwide its distribution is found throughout the North Africa, Southern Europe, Central and Western Asia as main diversity centre.[8] In western Asia, its distribution is found in the desert region which extends to the Western Rajasthan and Southern Punjab in India, Northeast Afghanistan, Boogtee Hill in Pakistan, Armenia, Persia and Syria.[9]

According to Shetty and Singh (1991), *Calligonum* (one species) is out of four genera of Polygonaceae which are distributed in Thar desert of Rajasthan naturally.[10,11] Arid region of Rajasthan covers from 24°N to 35.5°N and 70.7°E to 76.2°E and *C. polygonoides* shows its presence in Jaipur, Barmer, Churu, Bikaner, Jodhpur and Jaisalmer districts.[10] Shankarnarayan (1988) reported its growth on sand dunes as a psammophytic vegetation of Barmer, Bikaner, Churu, Jaisalmer, Jhunjhunu, Nagaur, Sikar and Shri Ganganagar.

Figure 3: Plate with parameters of *C. polygonoides*

Anemophily (cross pollination) of *C. polygonoides was reported by* Raju et al. (2001) which might be the reason of high diversity at chemical as well as molecular levels.[12]

Bewal and coworkers, analysed RADP marker of *C. polygonoides* and reported that plant showing diverse accessions of spreading and occupying geographic niches in arid regions is due to predominantly obligate out breeding behavior.[13]

PHARMACOGNOSTIC FEATURES

A. Morphological features

C. polygonoides is a small shrub (Figure 1). Sandy soil area is its natural habitat. IUCN has incorporated it in his Red Data Book being an endangered plant species.

Stem: Stem is having nodes and internodes which joints stem and branches conspicuously; *Roots*: shown as deeply branched, tapped; *Inflorescence*- spike; *Flower*: are white, small, bisexual and regular. Fruit are oblong and nut like; small and rounded seeds. May-June is the flowering and fruiting season. Small prostrate shrub with branched roots; leaves simple, needle like, stipulate and reduced to scale.[14]

Wahid et al (2005) reported in their study that plant bears long needle like leaves, while Al-Khalifa reported leaves as reducing. Temperature variations lead to difference in structures of leaves. With rise in temperature, leaf surface gets shorten to reduce the loss of water.[15,16]

B. Anatomical characteristics

Wahid reported anatomical features of leaves, stem and roots with very prominent cortex and thick epidermis. Thinner and double layered endodermis is present. Al-Khalifa *et al* (2006) also reported the same in xerophytes with widespread cortex.[15,16] Vascular tissues are radical and pericycle is reported in ring shape. Intense drought conditions lead to grand modifications in anatomy. Vessels get narrower in wood with presence of growth rings. Conducting phloem is in comparatively narrow depth; green photosynthetic shoots show higher specific mass.[16]

Leaf: Epidermis and mesophyll is found as normal leaf with parenchymatous structures. Star like vascular bundles are clearly seen. Presence of water storing tissues is found in the center.[17]

In roots, parenchymatous cells are seen in dense arrangement in cortex, which shows a large storage of water. Protoxylems and metaxylems are clear.[17]

PHYTO-CHEMICAL REVIEW

Two new butanolides- Calligonolides A (1) and B (2) were isolated by Yawer et al. They also isolated a new steroidal

ester (3) from the whole plant of *C. polygonoides*. Compounds 1-3 showed moderate lipoxygenase inhibitory potential.[18]

Ahmed isolated a new flavonoid, kaempferol-3-0-3- D-(6"-n-butyl glucuronide) from aerial parts of *C. polygonoides*. In addition, quercetin 3-0-p-D-6"-n- butyl glucuronide), (+)-catechin, kaempferol-3-0-p-D- (6"-methyl glucuronide), quercetin-3-0-p-D-(6"- methyl glucuronide), quercetin- 3- O-glucuronide, astragalin, quercetin-3-O-gluco- pyranoside, taxifolin, dehydro- dicatechin A were also isolated from the aerial parts. Selected isolates were also examined for their cytotoxic activity against MCF-7 and HepG2.[19]

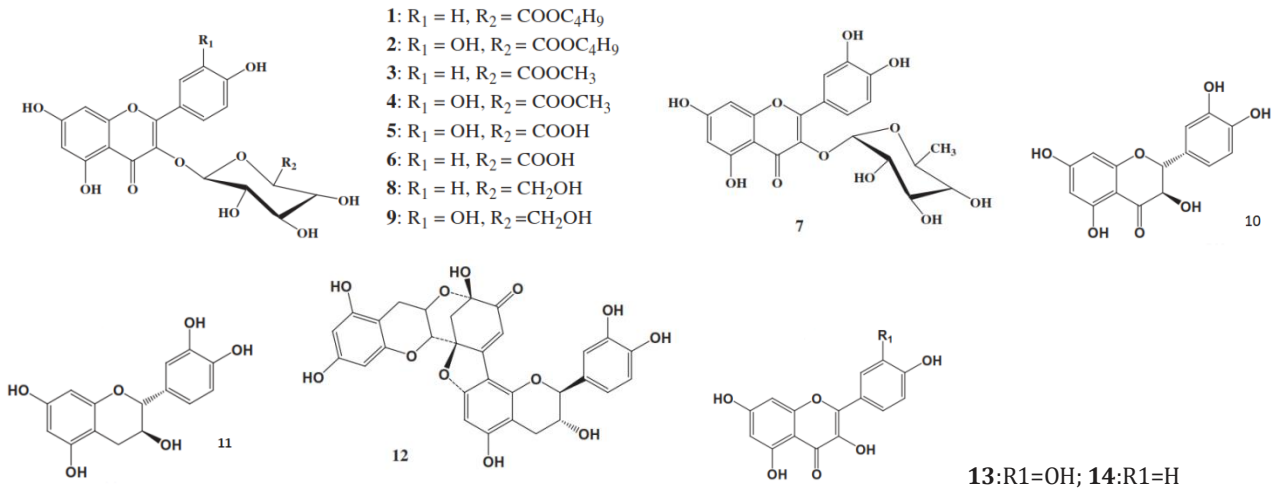

Figure 4: Flavanoid compounds isolated from *C. polygonoides subsp. comosum* (Ahmed et al. 2016)

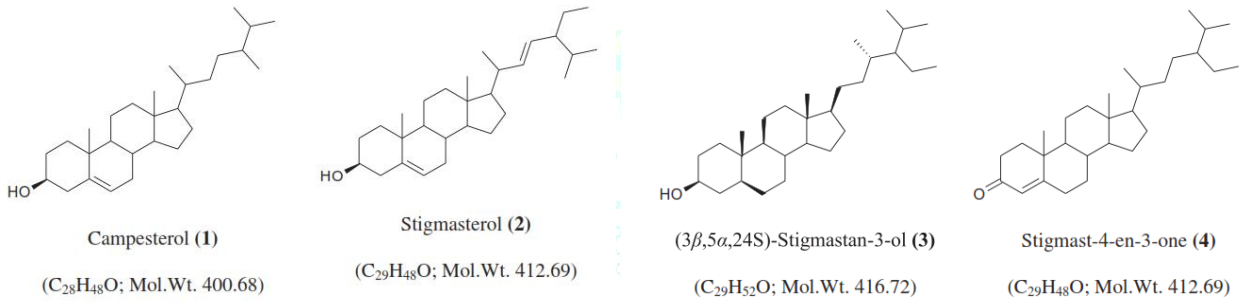

Figure 5: Steroidal compounds isolated from methanolic root extract (Samejo, 2013)

Muhammed et al analyzed chemical composition of essential oil from fruit and stem of *C. polygonoides* by using GC-MS. (Z,Z)-9,12-octadecadienoic acid, hexadecanoic acid, nonacosane, tetradecanoic acid, heptacosane, hentriacontane, dodecanoic acid and pentacosane were found as the major components in essential oil of fruit; while hexadecanoic acid, (Z,Z)-9,12-octadecadienoicacid, dodecanoic acid, (R)-massoia lactone, nonanoic acid and pentadecanoic acid were found as the major components of the stem oil.[20]

Table 1: Flavanoid compounds isolated from *C. polygonoides subsp. comosum* (Ahmed et al, 2016)

S. No.	Compound	Structure reference
	quercetin 3-O-β-D-(6''-n-butyl glucuronide)	Lin et al. 2011
	kaempferol-3-O- β -D(6''-0-0-methyl glucuronide)	Al Sayed et al. 2010
	quercetin-3-O- β -D-(6-0-0-methyl glucuronide)	Lin et al.2009
	quercetin-3-O-glucuronide (mequilianin)	Badria et al. 2007
	kaempferol-3-O-glucuronide	Badria et al. 2007
	quercetin-3-O-α-rhamnopyranoside (quercitrin)	Badria et al. 2007
	astragalin	Markham & Ternai 1976
	quercetin-3-O-glucopyranoside (isoquercitrin)	Badria et al. 2007
	taxifolin	Kim et al. 2009
	(+)-catechin	Badria et al. 2007
	dehydrodicatechin A,	Badria et al. 2007
	quercetin	Badria et al. 2007
	kaempferol	Badria et al. 2007

Ahmed et al (2016) compiled the isolated flavanoids. Presence of dehydrodicatechin A, kaempferol, kaempferol-3-O-rhamnopyranoside, quercetin, quercitrin, (+)-catechin, isoquercitrin, quercetin-3-O-glucuronide, kaempferol-3-O-glucuronide, pro-cyanidines, violaxanthin carotenoids, β-sitosterol-3-O-glucoside and neoxanthin carotenoids was reported.[21,19]

Samejo et al (2013) isolated steroidal compounds from methanolic extract of roots, identified as campesterol (1), stigmasterol (2), 3b,5a,24(S)-stigmastan-3-ol (3) and stigmast-4-en-3-one (4).[22]

The major constituents of the buds oil identified are ethyl homovanillate (11.79%), R-massoia lactone (8.79%), 4-(2,6,6-trimethylcyclohexa-1,3-dienyl)but-3-en-2-one (5.12%), (Z,Z,Z)-9,12,15-octadecatrienoic acid (4.08%), heptacosane (3.28%), neophytadiene (3.26%) and phytol (2.50%). Whereas, the main components of the roots oil are (-)-drimenol (29.42%), heptacosane (14.14%), 2-nonadecanone (8.04%), mono (2-ethylhexyl) ester 1,2-benzenedicarboxylic acid (7.67%), squalene (7.25%), nonacosane (5.32%), pentacosane (4.01%), tricosane (2.48%) and tetracosane (2.15%). Thus, from these results, it has been inferred that the composition of volatile oils extracted from the buds and roots is different.[20,23]

The plant contains calligonoides, steroidal ester, beta-sitosterol glucoside, teracosan-4-olide and ursolic acid.[18] Drimenol (29.42%) was isolated from roots.[9,22]

PHARMACOLOGY

Cytotoxic potential of isolated flavonoids was examined against MCF-7 and HepG2.[19]

Yawer isolated calligonolides A and B, two new butanolides, and a new steroidal ester and observed their moderate inhibitory activity against soybean lipoxygenase. In addition, few known compounds were also isolated.[18]

Another species of *Calligonum viz. Calligonum comosum*, have been reported by Liu et al (2001) as efficacious in inflammation, by Handa et al (2006) against stomach ailments and toothache.[24,25]

Khan et al (2015) reported antioxidant, antifungal and cytotoxic potential against brine shrimps. They evaluated methanolic extract of whole plant.[26]

Biosorbent potential of *C. polygonoides* was illustrated by Nasrullah et al (2015) and demonstrated that its ash is an effective benign biosorbent for methylene blue to remove it from aqueous solutions. The mechanism behind this was demonstrated with the presence of multiple –OH groups which are available to interact mechanically with dye ions being more exposed because of easy penetration of dye ions to the microstructure of adsorbent.[27]

ETHNO-PHARMACOLOGICAL USES

Bewal reported use of its roots and thick branching stems as fuel. Aqueous paste has been utilized for the management of opium poisoning (as antidote) and also reported as effective antidote against various symptoms of poisoning of various herbs [4]. Traditionally, plant extract is given to animals to treat colic.[28]

Historically, it is the dominant woody perennial shrub in active sand dunes and stabilize sand fields in most of the desert area.[2,29]

In deserts, Phog is used as a fuel especially in winters. During severe draught, animals feed on it. Decoction of roots mixed with catechu is used as gargle in sour gums. Seeds being rich in energy (360 kcal %), protein (6.05 %), iron (3.52 mg %), calcium (211 mg %), fibre (15.70 %) and phosphorous (427 mg %) are dried and consumed with curd based preparation like "Rayata". The same has also reported by Suresh et al (2008) for treatment of sun-stroke. In deserts of Arabian countries also, the same use was reported for flower buds (locally called as "Lasson") by mixing with butter milk (whey) and salt during summers.[30] Delicious local preparations in Arabians are reported to be made with bread and flowers with or without cooking in clarified butter or coconut oil.[4,11] Aqueous oral paste is also reported as antidote for heavy opium intake.[31]

Being a shrubby plant, it binds soil and is used to prevent erosion and thus help in stabilizing sand dunes. The wood is used in building huts and coal prepared from the plant is used by iron and gold-smiths.[32,33]

Extract is used in cases of typhoid, whereas gargles of plant decoction are used to cure sore gums by Bhil and Garasia (Bhandari, 1978; Singh and Pandey, 1998). Ethno-veterinary uses are also reported for treatment of colic (extract) and dysuria (decoction).[34]

The possible ways of utilization of Phog are described in terms of: food value, fodder value, medicinal value, fuelwood, agricultural uses, live hedge, social and religious aspects, material for huts and for rehabilitation of degraded lands.[35]

CONCLUSION

C.polygonoides is a very less explored desert plant. There is a need to explore it as it is having a wide range of traditional uses.

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