A Review on Phytochemical and Pharmacological Aspects of *Ochradenus baccatus*

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ABSTRACT. *Ochradenus baccatus*, also known as "Taily Weed," is a perennial shrub that belongs to the Resedaceae family and is often used as a folk medicine for the treatment of headache, fever or sexual disorders in the Middle Eastern countries. It is also used as an antibiotic, cooling agent and deodorant. Due to its widespread use in traditional medicine in the Middle Eastern countries and lack of scientific evidence, it is being investigated for its phytotherapeutic potential in different disease conditions.

Keywords: *Ochradenus baccatus*, Folk medicine, Middle East, Taily Weed, Anti-inflammatory, Anti-oxidant.

1 Introduction

The perennial shrub *Ochradenus baccatus (O. baccatus)* commonly known as Taily Weed is a member of the Resedaceae family and grows commonly throughout the Middle East. *O. baccatus* is the most valuable medicinal herb with abundant anti-inflammatory and antioxidant compounds. Ochradenus species are annual or perennial herbs. Branch colors change from green to brown as they grow old and are rugose costate on the straggly, frequently heavily branched, glabrous stem. Simple leaves are spiral, single or bud, linear oval-shaped, with an entire edge or occasionally a little groove towards the base. The petiole is sessile. Flowers are either bisexual or unisexual, zygomorphic, perigynous, bracteate, or pedicellate, with 5–6 oblong sepals, diminutive petals, and a unilateral, pale yellow, fleshy disc. Anthers are ellipsoid, stamens 10-15, hypogynous, and placed on a discoid. The ovary is superior; unilocular; sessile; ovoid; closed at the top; three to four carpeted; beaked; numerous ovules; three placentas; style is short or absent; stigma capitate. Fruit is frequently a berry or a capsule. Few are oblong or kidney-shaped seeds [1-3].

COMMON NAMES

English: Taily weed, Pearl plant, Qardi, Qurdi

Arabic: Kardhi and Alandra

TAXONOMICAL CLASSIFICATION

Division	Angiospermae
Super Division	Spermatophyta
Class	Dicotyledoneae
Order	Brassicales
Family	Resedaceae
Genus	*Ochradenus*
Species	*Ochradenus baccatus*

2 Geographical distribution

O. baccatus is an indigenous plant widely spread in the Arabian Peninsula. It is also found in countries like Afghanistan, Saudi Arabia, Iran, Jordan, Syria, Oman, Yemen, United Arab Emirates, Palestine, Bahrain, Kuwait, Israel and Pakistan. In Africa, it is found in Chad,

Ethiopia, Socotra, Somalia, Sudan, Egypt, Libya and Niger.

In Indian subcontinent, it grows in the states of Gujarat, Maharashtra and Rajasthan [1-3].

3Botanical description

Macromorphology

The tall perennial shrub *O. baccatus* grows to a height of 2 to 2.5 meters and a diameter of 2 to 5.5 metres. The plant has spike-like golden flowers and is polygamous. In the dry desert, the stem's spinescent branches grow into dense shrubs. It blooms in March to May [4].

1Leaves

The leaves are dense, alternate, caudate, stalked, exfoliate, and deciduous. They are linear, dark green on the exposed surface, pointed at the apex, symmetrical throughout the base, 1-5cm long and 1.5-4mm wide. They have web-like feathery veins. The midrib is slightly protruding below and slightly concave above [4].

2Stem

Stem is yellow-green in colour, erect, woody, glabrous, and cylindrical, with single-legged branched twigs or simple branches. Branches may end in sharp, thorny ends. It is firm: internodes 1.5 to 7cm long and 0.5 to 1cm in diameter. The trunk has a short green cleft in the outer bark and a yellow cleft in the middle. It has a slight aroma and a little bitterness [4].

3 Root

Root is cylindrical and spindle-shaped. The taproot is 15-35 cm long and 3-6 cm in diameter at its widest point. It has weak branches, few lateral roots, and small fine roots. The surface is rough, pale yellow with fibrous cuts. It has a faint scent and a little bitterness [4].

Micromorphology

A cross-section of the leaf shows an equilateral structure. Both palisade layers are continuous in the midrib area. The midrib is more conspicuous on the bottom. It exhibits an arc of 4-7 collateral vascular bundles with collenchymatous pericycle. The cross-section of the old trunk is almost circular. The outer epidermis surrounding the parenchymal cortex shows 5-8 rows of sub-epidermal chlorenchyma with small clusters of sclereid. The pericycle consists of discontinuous rings of small clusters of lignified fibers followed by sclereid. Vascular tissue is formed from the complete ring of the lateral phloem. Inner xylem with cambium in between. The pith is broad and lignified. Young trunks are similar in cross-section, but the cortex lack the sclereids. The vascular tissue consists of 18-22 independent vascular rings with a parenchymal pericycle and a broad parenchymal pith. Outline of cross-section of mature root has a round shape. The vascular tissue is surrounded by a large phelloderm and an external cork that is brownish in colour. A well-developed cambium divides the vascular tissue's outer phloem and inner xylem. In young roots, the primary xylem is diarch [4].

1 Epidermis

A thick, smooth cuticle covers both of the epidermis of lamina polygonal cells, which have straight or slightly curved dorsal walls. Neural epidermal cells, like stem cells, extend axially with straight anticlinal walls.

2 Stomata

It lack subsidiary cells rarely have unequal sized subsidiary cells. They are present on both leaf surfaces and stems. They have an oval or rounded outline and measure between 25 and 35 µm, 31-38 µm in length, 21-27 µm in height and 30-37 µm in width.

3 Trichomes

Lack glandular and enveloping trichomes.

4 Cortex

The midrib cortex is parenchymal and has superior and inferior palisading cells. The stem cortex is formed of outer chlorenchyma and an inner parenchyma. It shows thick, lignified, perforated walls and scattered clusters of sclereids with broad lumens 29–54 µm long and 16–19 µm wide. In young strains, the cortex does not show sclereids but is dispersed with oval secretory cells 16–33 µm in diameter. The pericycle of young stems is parenchyma, the pericycle of older stems is composed of clusters of pericyclic fibres followed by sclereids, which are fusiform, with thick lignified walls, serrated margins, and It has a sharp or blunt tip and a wide or narrow lumen from 392 to 437 µm in length and 11- 40µm in diameter. Sclerids have thick lignified perforated walls and wide lumens. It is 22-46µm in length and 18-20µm in width [4].

5 Vascular tissue

Leaf vascular bundles consist of the radial xylem and the underlying phloem zone. The xylem is composed of spiral-shaped, lignified, perforated, and annular vessels with diameter of 6-23µm. Some of the tracheids have perforated lignified walls and are 43-88µm in length and 6-11µm in diameter. The wood parenchyma contains cellulose. In a young stem, the vascular tissue is composed of 18–22 separate collateral bundles of outer cellulose phloem and inner lignified helix and stigma vessels, with diameters of 7-12µm and wall lengths of 43-10µm. 88 µm, 6 to 11µm in diameter. The bark of wood contains cellulose. In young stem, the vascular tissue consists of 18 to 22 separate collateral

vascular bundles of the outer cellulosic phloem and of the inner lignified spiral and perforated vessels, 7 to 12 μm in diameter. The vascular tissue of the old root and stem makes a complete ring with outer phloem and the medial xylem, with an intervening cambium and traversed by the medulla rays. Moderately thick-walled cellulose components comprised the phloem. The xylem is completely lignified. Fusiform in shape, wood fibres have thick, lignified walls, moderately narrow lumens, and blunt or pointy ends. They are 283 to 488 μm in length and 5 to 19 μm in diameter. The lignified walls of the diffused or paratracheal wood parenchyma, which is composed of polygonal, axially elongated cells that are relatively thick and perforated, exhibit many small holes. The size is 54-75μm in length and 5-28μm in diameter. Tracheids are few polygonal, thick-walled showing oval bordered pits. They measure 85 to 132μm in length and 21 to 33 μm in diameter. The tracheidal vessels are very less showing rounded lateral perforation and lignified perforated walls. They measure 101 to 135 μm in length and 16 to 30 μm in diameter. Medullary rays are uni- to biseriate made up of lignified rectangular cells with thick perforated walls in the xylem region and are cellulosic in the phloem region. They are7–53 μm in length and 3–39 μm in width in the phloem region and 9–48 μm in length and 5–16 μm in width in the xylem region [4].

6 Cambium

The cambium is composed of 2-4 rows of thin-walled, sub-rectangular, tangentially elongated meristematic cells.

7 Pith

Pith of mature stem is broad, comprises of large polyhedral cells, moderately thick and perforated lignified walls and narrow intercellular spaces. Sizes range from 19 to 52 μm in length and 11 to 35 μm in width. In young stems, it is parenchyma. Cell diameters range from 16 to 41 μm.

8 Periderm

It can be seen only in old roots.

9 Cork

Cork consists of 8 to 12 rows of polygonal to rectangular radially arranged cells with limited thick suberized walls and brownish contents. They are 23-60 μm in length and 8-41μm in width. Phellogens are derived from pericycle rather than old roots. Phelloderms are very wide and consist of 30-40 rows of polygonal, limited thick-walled parenchyma. It shows clusters of thick-walled, polygonal perforated lignified sclera with narrow or wide lumens. 11-42 μm in length, 11-27 μm in width. Simple polyhedral starch granules with a central split hilum 6–9 μm in diameter are present in the stem bark, roots, and stem pith [4].

4Phytochemistry

Phytochemical screening of the plant exhibited the presence of alkaloids, coumarins, saponins, fatty acids and steroidal compounds. The isolated phtoconstituents include Quercetin 3-O-p-coumaryl(1→6)- β -glucosyl(1→6)- β -glucoside-7-O- α rhamnoside, Quercetin 3-O- β -glucosyl(1→2)- α -rhamnoside-7-O- α -rhamnoside, Quercetin 3-gentiobioside, Isoquercitrin, Quercitrin, Kaempferol glycosides, Rutin, Luteolin, Afzelin, Astragalin and phenols and fatty acids [3,4]. It has high concentrations of glucosinolates also [5, 6].

5Traditional uses

It is used as folk medicine to treat different conditions like headache, fever, sexual disorders, urinary dysfunction, diabetes etc. It is also used as an antibiotic, cooling agent, and deodorant [7].

6Pharmacological activities

O. baccatus is a folk medicine for local people, but scientific evidence is lacking for its medicinal properties. Very few studies have explored its therapeutic potential and following pharmacological activities have been reported so far (Table 1).

1Antioxidant and anti-inflammatory activities

Ethanolic extract of *O. baccatus* were evaluated for their antioxidant and anti-inflammatory activities. Effect of its ethanolic extract was investigated in carrageenan induced paw edema and acetic acid induced ulcerative colitis in rats. Plant extract showed antioxidant and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activities. Oral pre-treatment with the extract protected against diarrhoea, colonic ulceration, and inhibited myeloperoxidase (MPO) activity in the colonic mucosa of rats. Similarly, treatment with the extract reducted carrageenan induced paw edema significantly. Thus ethanolic extract was found effective in inflammation and ulcerative colitis [8,9].

2Anti-tumour

Aqueous extract of aerial parts of *O. baccatus* were used to screen the antitumor effects in an in vitro experiment by using HepG2 human hepatocellular carcinoma cells. MTT (3-(4, 5-Dimethylthiazolyl-2)-2, 5-Diphenyltetrazolium Bromide) test was performed to assess the cytotoxicity of *O. baccatus* plant extract by exposing HepG2 cells to varying concentrations (0–4 mg/mL) for 24 or 48 hours [10]. *O. baccatus* extract had a significant antiproliferative effect Half-maximal inhibitory concentration, IC50 =1.5 mg/mL) in HepG2 cells after 24 hours of exposure. After 48 hours of exposure, IC50 was found to be 0.83mg/mL. The study reported antitumor effects of *O. baccatus* against HepG2 cells [10].

3Anti-microbial activity

Antimicrobial activity of extracts of *O. baccatus* was measured using agar diffusion and minimum inhibitory concentration assays. Micro-organisms used in the study were: *Staphylococcus aureus; Escherichia coli*; and the fungus, *Candida albicans*.The results showed that ethanol and ethyl acetate extracts inhibited the growths of the two tested bacterial micro-organisms i.e. *Staphylococcus aureus* and *Escherichia coli*. However both were inactive against *C. albicans* which was significantly inhibited by n-hexane and chloroform extract [11, 12].

4Hypolipidemic activity

Effect of *O. baccatus* on the biochemical and histopathological parameters in experimental animals were also investigated. Rats were administered complete extracts of *O. baccatus* and their lipid profile, glucose levels, liver, and kidney functions were assessed in blood samples. The histopathological changes were assessed in the kidney and liver tissues. No significant differences in the serum levels of blood urea, creatinine, alanine aminotransferase, aspartate transaminase, cholesterol and blood glucose were observed. The results suggested that *O. baccatus* is safe to kidneys and livers and does not alter blood glucose. However, reduction in levels of serum triglycerides with higher dose of *O. baccatus* extract indicated its hypolipidemic activity [11, 12].

Table.1 Pharmacological activites reported for *O. baccatus.*

Activities	**Models**	**Type of extract**	**Effects or functions**	**References**
Antioxidant and anti-inflammatory	*In –vitro,* carrageenan induced paw edema and acetic acid induced ulcerative colitis	Ethanolic extract	Antioxidant and DPPH radical scavenging activities. Protection against diarrhoea and colonic ulceration	8,9
Anti-tumour	*In –vitro (*HepG2 cells)	Aqueous extract	Inhibits the growth of HepG2 tumor cells	10
Anti-microbial	*Staphylococcus aureus; Escherichia coli*; and the fungus, *Candida albicans*	Aqueous extract	Inhibits the growth ofStaphylococcus aureus; Escherichia *coli*; and the fungus, *Candida albicans*	11, 12
Plant nematicidal activity	*Meloidogyne javanica*	Aqueous extract	Nematicidal action and may be used to control nematodes	14
Male reproductive activity	Male Albino Wistar rat	Ethanolic extract	No toxic effects on the male reproductive organs	13

5Male reproductive activity

As *O. baccatus* is traditionally used for the treatment of male sexual disorders, effect of its extract on male-reproductive system was investigated. The study was performed on albino Wistar rat model. 78 healthy adult males were equally divided into 13 groups. The doses of *O. baccatus* ethanol extract were 100, 200, 400 mg/kg. These doses were given daily via oral route for 65 days. In the acute toxicity test, the result showed the safety of *O. baccatus* with no

toxicity symptoms produced during the observation period. No significant change was observed in the relative weight of the testes, seminal vesicles and ventral prostate in *O. baccatus*-treated animals. There was no effect on the serum testosterone, prolactin, follicle-stimulating hormone (FSH) and luteinizing hormone (LH) levels after *O. baccatus* treatment. There was no alteration observed on sperm count, sperm viability, sperm motility and fertility test in *O. baccatus* treated groups indicating that there is no toxicity on the male reproductive organs [13].

7Other activities

1 Nematicidal activity

In vitro experiments were carried out to assess the nematicidal activity of aqueous extract of *O. baccatus* against the root-knot worm *Meloidogyne javanica*. 48 hour exposure with 4% root-core extract immobilized 100% of second-stage juveniles while 8% root-core extract reduced hatching by 87%. The results suggested that *O. baccatus* has a promising potential in plant-parasitic nematode control and can be explored further as a nematicide [14].

2Supplementary feed for grazing animals

O. baccatus is traditionally used as nutritional supplementary feed to maintain livestock or grazing animals such as (goats, sheep, and camels).[15] Heneidy et al., studied the nutritive value and palatability of *O. baccatus* among other plants on grazing animals at different locations and periods.[16] It was found that the consummable part are the young branches that seemed to be palatable.[17] Results showed that grazeable parts of *O. baccatus* have the highest nitrogen free extract (NFE) and crude fibre (CF), representing the maximum amount among other studied plants. It also showed the minimum percentage of crude proteins in the targeted plants.[18] It has the highest organic matter content. Thus despite its low ability to contribute to the gross energy content, *O.[19] baccatus* has the maximum digestible energy and metabolizable energy contents in the grazeable parts [20,21].

8Conclusion

O. baccatus contains high amount of flavonoid and polyphenolic compounds with significant antioxidant and anti-inflammatory effects. It possesses anti-inflammatory, anti-ulcer, anti-tumour, anticancer, hypocholesterolemic and anti-microbial activities. Although this plant is used in folk medicines to treat many conditions, there is a lack of sufficient studies to evaluate its efficacy. Therefore, extensive research should be conducted on this plant to determine how extensively it may be used to cure a variety of ailments.

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