Ethnobotanical, Phytochemical and Pharmacological Potential of Cycas revoluta Thunb - A review

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ABSTRACT
Cycas revoluta Thunb. or sago palm is an important species of cycads, endemically found in Japan, especially in southern Japan throughout the Ryukyu Island. The species is of massive ethnobotanical significance and used at large by the poor people and population of hilly areas in famine condition. It is mainly valued for its starch contains and used as fiber to construct cloth and ropes. It shows several pharmacological activities since different parts of this plant contain several chemicals like glycodies, amino acids, flavonoids, fatty acids and lectins. The aim of the present review is to compile all the informations available related to taxonomy, ethnobotany, chemical constituents and their pharmacological activities to explore the importance of C. revoluta.

Key words: Ethnobotany, Phytochemistry, Pharmacology, Cycas revoluta, Endemic species.

INTRODUCTION
Cycas revoluta Thunb. is a gymnosperm belonging to the family Cycadaceae. Sago Cycas, Sago Palm. Sotetsu Nut, False Sago, Sago Palm of Japan and king sago palm are some common name of this species. Cycads have long been known to cause toxicity. Sago starch requires appropriate processing to eliminate its toxin before use otherwise, it can lead liver damage, vomiting and even death. In geological time scale, Mesozoic era was the golden period of this plant group. Many rare and endangered species are present in Cycadaceae family. It is endemic to Japan but originally came from Southeast Asia. At present it is bounded to warm climate that previously found worldwide. It is a xerophytic plant. It is bounded to warm climate that previously found worldwide. It is a xerophytic plant. It is bounded to warm climate that previously found worldwide. It is a xerophytic plant.

TAXONOMIC DESCRIPTION
Cycas revulata is a palm-liked evergreen, slow-growing, medium sized, perennial, branched with multiple heads, woody, 0.5-2 m tall and 35–95 cm wide trunked dioecious tree which has a lifespan of more than 100 years. Stem of young age tree is tuberous while old tree has thick columnar and rough stem. Glossy green, thick, many, populous, large pinnately compound and 0.5 to 1.5m long leaves are found in it that have more than 100 linear leaflets with downward rolled margins and sunken midrib. Veins are absent in midrib. Male rachis is curled in young leaves. It bears both scal y and foliage leaves which are arranged in alternative manner. Scaly leaves are persistent and brown in colour and foliage leaves are pinnately compound and large with 60 cm length. Scaly leaves existing in more quantity than foliage leaves and play a role in the protection. Leaves have quadrangular and thickened petiole. Leaves are produced by the plant throughout the year and last for many years. The flowers of C. revoluta are dioecious it means that both female and male flowers are on different plants and an individual plant has either female flower or male flower. Flowering begins in May and ends in July. Male cones are characterized by sporophylls, narrowly ovoid to cylindrical, hairy, brown in color and a short up curved point with narrowly wedge shaped whereas loose, open, hairy, brown, densely brown hairs on sporophylls, apical lobe ovate, deeply laciniate margin with 12-18 tapered lobes characters are present in female cone. Cycas revoluta has...
anemophily and entomophily both type of pollination. A red coated approximately 3cm wide and 4 cm long and seeds are produced by C. revoluta. Normally seeds of cycads are heavy in weight that’s why they sink in water. Seeds of C. revoluta show very low percentage of germination.

**SCIENTIFIC CLASSIFICATION**

Kingdom- Plantae
Division- Cycadophyta
Class- Cycadophyta
Order- Cycadales
Family- Cycadaceae
Genus- Cycas
Species- revoluta

**ETHNOBOTANICAL POTENTIAL OF CYCAS REVOLUTA**

C. revoluta is very important ethnobotanical plant for the local people of hilly areas because it is used by them as medicinal and non medicinal purposes. It contains starch in a very good quantity so it is used as a food by different ways such as sago, flour, bread, cake, vegetables etc. Its different plant parts are also used to household needs and to treat many diseases. Household needs include funeral wreaths, decoration and the making of huts, ropes, cloths, brooms, baskets from plant parts (Table 1).

**PHYTOCHEMICAL CONSTITUENTS OF CYCAS REVOLUTA**

Many types of phytoconstituents have been extracted and isolated from different solvents of various plant parts of C. revoluta. The potent phytochemicals are lectins, flavonoids, lipids, chitinase, estragole, glycoside, nonprotein amino acid and essential oil. NaCl/Pi, chloroform, ethyl acetate, methanol, diethyl ether, petroleum ether, and ethanol are some solvents which have been used for extraction (Table 2).

**PHARMACOLOGICAL ACTIVITIES OF CYCAS REVOLUTA**

Researchers have been reported many kinds of pharmacological activities in C. revoluta like antiviral, astringent diuretic, antioxidant, antidiabetic, antimicrobial, antibacterial, antileishmanial activity, antifungal, cytotoxic, anticancer, antirheumatic. The detailed pharmacological activities are tabulated in Table 3.

| Plant part used | Use category | Processing method | Form of use | Purpose of use | Reference |
|----------------|--------------|-------------------|-------------|----------------|-----------|
| Stem           | Food         | Cut the stem, Chopped the pith and cortical cells and grind it. Then processed to remove toxins before use. After proper washing of extract with water | Sago Grains | Food source (starch) | 4         |
|                |              |                   | extract with water |                | 4         |
|                |              |                   | Drink          | Nutrition (A large amount of starch), valuable famine food | 4         |
|                |              |                   |                | Formation of wine | 4         |
|                | Medicine     | Take the pith of stem then wrapped in the animal skin and inter in the ground | Partially fermented stem | Nutrition (Bread) | 4         |
|                | Household    | Mixed coconut oil in Crushed Seeds or megasporophylland bark | Paste | Ointment for wound and sores | 4         |
|                |              |                   | Fiber | To prepare cloth and rope | 4         |
|                |              |                   |                | Nutrition | 4         |
|                | Food         | Tender leaves are boiled and decocation is prepared | Drink (tender leaves) | Treatment of flatulence and vomiting | 17        |
|                | Medicine     |                   | Tincture | Estrogen dependent carcinoma | 13        |
|                |              |                   | nursery stock | Hepatoma and cancer | 18        |
|                | Household    | Whole leaves | Decoration in festivals and marriages | 4         |
|                |              | Strong and leathery leaves | To prepare basket and brooms | 4         |
|                |              | Strong and leathery leaves | To thatch huts | 4         |
|                |              | Fiber | To prepare twines, rope and cloths | 4         |
|                |              | Manure | For growing mushrooms | 1         |
|                | Root         | Burying the roots by a house | After proper washing of extract with water | Nutrition | 4         |
|                |              |                   |                | Protect from lightning | 4         |

Table 1: Ethnobotanical importance of Cycas revoluta.
Table 2: Phytochemical constituents of Cycas revoluta.

| S.NO. | Plant parts          | Extract with                  | Chemical constituent                                                                 | References |
|-------|----------------------|-------------------------------|--------------------------------------------------------------------------------------|------------|
| 1     | Leaves               | NaCl/Pi Hydro-alcoholic and chloroformic extracts | 2,3-dihydro-4′-O-methyl-amentoflavone | 22, 23     |
| 2     | Leaf rachises        | homogenized with 1000 mL of deionized water Methanolic | Class V chitinase(CrChi-A) | 27         |
| 3     | Leaflet              | Ethyl acetate extract         | Dihydroamentoflavone (glycosidesprunin and vitexin-200-thamnoside) | 29         |
| 4     | Female cones         | Diethyl ether Chloroform + Methanol | Estragole (4-allylanisole) | 31         |
| 5     | Male cones           | Diethyl ether Chloroform + Methanol | Estragole (4-allylanisole) | 31         |
| 6     | Microsporangia       | Chloroform Chloroform + Methanol | Lipid (fatty acid composition) | 24, 24     |
| 7     | Pollen               | Chloroform Cold H.Ø.          | Lipid (Δ5 polymethylene-interrupted FA, Δ5, 11-octadecadienoic acid) | 32         |
| 8     | kernels of the seeds | Ice water + sulphuric acid Acetate buffer Phosphate buffered | Azoxy glycoside (Neocycasin) | 34         |
| 9     | Seeds                | Nonprotein amino acid (cycasthioamide and cycasindene ) | β-D-Glucosidase | 35         |
| 10    | Essential oil        | petroleum ether                | Linolenic acid (18.47%), Oleic acid (12.96%), Linoleic acids (10.9%), Palmitic acid (8.82%) and Octadecanoic acid (7.85%) | 39         |
| S.NO. | Plant part     | Activity/action          | Preparation                          | Against                                                                 | References |
|-------|----------------|--------------------------|--------------------------------------|-------------------------------------------------------------------------|------------|
| 1     | Coralloid root | Antiviral                | Crude extract in distilled water     | Tobacco mosaic virus, tomato ring spot virus, potato virus X, tomato aspermy virus, potato virus Y | 40         |
| 2     | Terminal shoots | Astringent diuretic      | 1. Hydro-alcoholic (More potent)      | S. aureus, B. subtilis, P. aeruginosa                                  | 2          |
|       |                | Antioxidant              | 2. Methanolic                        |                                                                          | 2          |
|       |                |                          | Hydrous                              |                                                                          | 25         |
|       |                | Antidiabetic             | Methanol, ethanol and ethyl acetate  |                                                                          | 42         |
|       |                |                          | Methanol and ethanol                 |                                                                          | 43         |
| 3     | Leaves         | Antimicrobial            | 1. Hydro-alcoholic (More potent)      | E. coli, Klebsiella pneumoniae and Saccharomyces cerevisiae               | 41         |
|       |                |                          | 2. Methanolic                        | Lactobacillus plantarum, Micrococcus luteus and Salmonella abony,        | 23         |
|       |                |                          | Hydro-alcoholic and chloroformic      | E. coli, S. aureus, P. aeruginosa, S. typhimurium, K. pneumonia and B. subtilis | 42         |
|       |                |                          | extracts                             |                                                                          | 44         |
|       |                |                          | Methanol, ethanol and ethyl acetate  |                                                                          |            |
|       |                | Moderate antibacterial   | Chloroform                           | Staphylococcus aureus                                                   | 28         |
|       |                | Antioxidant              | Methanol and its Methylene chloride  |                                                                          | 30         |
|       |                |                          | and ethyl acetate fractions          |                                                                          |            |
|       |                |                          | Methanol and its fractions 1. Ethyl  |                                                                          |            |
|       |                |                          | acetate (highest inhibitory activity)|                                                                          |            |
|       |                |                          | 2. n-butanol                         |                                                                          |            |
|       |                |                          | 3. Methylene chloride                |                                                                          |            |
|       |                | Antimicrobial            | Methanol and its fraction 1. n-butanol (most active) |                                                                        |            |
|       |                |                          | 2. pt ether                          |                                                                          |            |
|       |                |                          | 3. Methylene chloride                |                                                                          |            |
|       |                | Antileishmanial activity | Methanolic                           | L. donavani, Candida albicans, Candida glabrata, Candida krusei,         | 29         |
|       |                |                          |                                     | Cryptococcus neoformans Aspergillus fumigatus                           |            |
| 5     | Leaf rachis    | Antifungal               | Methanolic                           |                                                                          | 29         |
|       |                |                          |                                     | Trichoderma viride                                                       | 27         |
| 6     | Female Cone    | Antimicrobial            | Chloroformic                         |                                                                          | 23         |
|       |                |                          |                                     | E. coli, Lactobacillus plantarum, Micrococcus luteus, Salmonellaabony,   |            |
|       |                |                          |                                     | Candida albicans, Aspergillus niger and Methicillin resistant strains   |            |
|       |                |                          |                                     | of Staphylococcus aureus (MRSA).                                         |            |
| 7     | Male Cone      | Anticancer               | Methanolic                           | Colon cancer                                                            | 46         |
| 8     | ovule          | Antibacterial            | Methanolic extract                   | E. coli, Pseudomonas, Staphylococcus aureus, Bacillus cereus             | 47         |
|       |                |                          |                                     |                                                                          | 2          |
|       |                | Antirheumatic, Expectorant, and tonic | phosphate buffered saline          | S. epidermidis, Bacillus subtilis, Pseudomonas aeruginosa, and          | 36         |
|       |                |                          |                                     | Escherichia coli                                                        |            |
| 9     | Seeds          | Antimicrobial            | phosphate-buffered saline            |                                                                          | 48         |
|       |                |                          |                                     | Erwinia carotovora subsp. carotovora, Agrobacterium rhizogenes, Agrobacterium radiobacter, Clavibacterium michiganensis subsp. michiganensis, Curtobacterium flaccum faciens pv. oortii, Geotrichum candidum |            |
|       |                | Anticancer               | phosphate-buffered saline            |                                                                          | 36         |
|       |                |                          |                                     | human epidermoid cancer (Hep2) and colon carcinoma cells (HCT15)         |            |
CONCLUSION
This review comprises ethnobotanical, phytochemical and pharmacological potential of *Cycas revoluta*. The different plant parts are used as food, medicine, liquor, fiber and other household purposes and also used to cure many diseases like piles, painful urination, flatulence and vomiting by local population of hilly areas. Present review concluded that large number of chemicals like lipids, flavonoids, cycasin, lectin, peptides, biflavonoid are present in this plant hence it shows several pharmacological activities such as antioxidant, anticancer, antileishmanian, antifungal, antibacterial and antimicrobial etc.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest.

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**GRAPHICAL ABSTRACT**

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**Cite this article**: Deora GS, Shekhawat MK, Sarswati. Ethnobotanical, Phytochemical and Pharmacological Potential of Cycas revoluta Thunb - A review. Pharmacogn J. 2020;12(5):1165-71.