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Review Article

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 glycosides, 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,[1] Sago Palm of Japan and king sago palm[2] are some common name of this species. Cycads have long been known to cause toxicity.[3] Sago starch requires appropriate processing to eliminate its toxin before use otherwise, it can lead liver damage, vomiting and even death.[4] In geological time scale, Mesozoic era was the golden period of this plant group.[5] Many rare and endangered species are present in Cycadacece family.[6] It is endemic to Japan but originally came from Southeast Asia. At present it is bounded to warm climate that previously found worldwide.[7] It is a xerophytic plant.[4] Sago palm is broadly distributed from southern Kyushu to Iriomotejima Island throughout the Ryukyu Islands on the rocky coast.[5,8] *C. revoluta* population size is large in several regions.[9] *C. revoluta* is widely cultivated trees, occurred in subtropical, tropical and temperate regions.[10] It is a cycad that easily affected by water logging but can tolerate the drought and frost.[1] It has a capacity to fix nitrogen in loamy (medium), sandy (light) and well- drained soil. It can grow in basic, neutral and acid soil.[7] The name of this species of cycads is *Cycas revoluta* because of its revolving margin of leaflet. It is very good specimen as bonsai.[4]

It has several medicinal properties so its different parts are used to treat many diseases like estrogen dependent carcinoma, cancer, hepatoma, diarrhea and dysentery, flatulence, vomiting, piles and wound. *C. revoluta* is the utmost famous ornamentals among the cycads. In the Philippines and Indonesia, Cycads leaves are used as a vegetable and root nodules of *C. revoluta* which are edible and have been reported as a 'potato-like' substance.[11,3] Starch grains that are obtained by its pith and cortical cells of stem are used by the poor people and people of hilly area in starvation condition. Seeds and pulps (removed basal offsets) are used to propagate this species.[12]

In this review the present authors tried to compile all the informations related to its taxonomy, ethnobotanical uses, phytochemistry and pharmacological uses comprehensively to explore the utility of *C. revoluta*.

TAXONOMIC DESCRIPTION

Cycas revulata is a palm- liked evergreen, slow-growing, medium sized, perennial, branched with multiple heads,[4] woody,[13] 0.5-2 m tall[14] and 35–95 cm wide trunked dioecious tree which has a lifespan of more than 100 years.[15] Stem of young age tree is tuberous while old tree has thick columnar and rough stem.[4] 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.[16] Veins are absent in midrib. Main rachis is curled in young leaves. It bears both scaly 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 thicked petiole.[4] Leaves are produced by the plant throughout the year and last for many years.[14] 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.[7] 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.[1] *Cycas revoluta* has

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anemophily and entomophily both type of pollination.[14] A red coated approximately 3cm wide and 4 cm long and seeds are produced by *C. revoluta*.[8] 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.[12]

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.

Table 1: Ethnobotanical importance of *Cycas revoluta*.

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.	Sago Grains	Food source (starch)	4
		After proper washing of extract with water	extract with water	Nutrition (A large amount of starch), valuable famine food	4
			Drink	Formation of wine	4
		Take the pith of stem then wrapped in the animal skin and inter in the ground	Partially fermented stem	Nutrition (Bread)	4
	Medicine	Mixed coconut oil in Crushed Seeds or megasporophylland bark	Paste	Ointment for wound and sores	4
	Household		Fiber	To prepare cloth and rope	4
Leaves	Food		Young leaves are boiled and eaten as vegetables	Nutrition	17
	Medicine	Tender leaves are boiled and decoction is prepared	Drink (tender leaves)	Treatment of flatulence and vomiting	17
			Tincture	Estrogen dependent carcinoma	13
				Hepatoma and cancer	18
	Household		nursery stock	funeral wreaths and church festivals	4
			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 mashrooms	1
Root	Food		After proper washing of extract with water	Nutrition	4
		Burying the roots by a house		Protect from lightning	4

			Flour	Used to form bread, many native sweets/dishes, steam cakes and wine	4
Seed	Food		Edible (raw and cooked)	Nutrition	19
			Noodles and confectionary	Starch of seed is nutritive	20
		Powdered and mix with Brown rice then fermented ("date miso" or "sotetsu miso")	Edible	Nutrition	7
	Medicine	Flour is prepared by dry seeds	Flour	Medicine to treat piles	4
		Extract is prepared from seeds	Extract	To diagnose many tumors	13
Cone	Medicine	Powder is prepared by crushing dry cones	Powder	In the painful urination by the hilly people of Northeast India	21
Pollen grain	medicine			Health benefits	4

Table 2: Phytochemical constituents of *Cycas revoluta*.

S.NO.	Plant parts	Extract with	Chemical constituent	References
1	Leaves	NaCl/Pi	Lectin	22
		Hydro-alcoholic and chloroformic extracts	2,3-dihydro-4′-O-methyl-amentoflavone	23
		Hydrous	Lipid	24
			Essential oil (γ-ketovaleric acid major component)	25
			Flavonoid (2,3-Dihydroamentoflavone, 2,3-dihydrohinokiflavone, amentoflavone, Hinokiflavone and sotetsuflavone	26
2	Leaf rachises	homogenized with 1000 mL of deionized water	Class V chitinase(CrChi-A)	27
		Methanolic	Biflavanoid [(2S, 2″S)-2,3,2″, 3″-tetrahydro-4′,4‴-di-O-methylamentoflavone (tetrahydroisoginkgetin; 2)]	28
3	Leaflet	Ethyl acetate extract	Dihydroamentoflavone (glycosidesprunin and vitexin-200-rhamnoside)	29
			flavonoids and biflavonoid (glucoside β amyrin, neohesperidin, rutin and β sitosterol)	30
		Chloroformic extract	2, 3-dihydro-4′-O-methyl-amentoflavone	23
4	Female cones	Diethyl ether	Estragole (4-allylanisole) Fatty acid ester	31
5	Male cones	Diethyl ether	Estragole (4-allylanisole) Fatty acid ester	31
		Chloroform + Methanol	Lipid (fatty acid composition)	24
6	Microsporangia	Chloroform + Methanol	Lipid (fatty acid composition)	24
7	Pollen	Chloroformic	Lipid (Δ5 polymethylene-interrupted FA, Δ5, 11-octadecadienoic acid)	32
		Cold H_20.	Glycoside (Cycasin)	33
8	kernels of the seeds	Ice water + sulphuric acid	Azoxy glycoside (Neocycasin)	34
		Acetate buffer	β -D-Glucosidase	35
9	Seeds	Phosphate buffered Saline containing protease inhibitor cocktail (Sigma)	Small peptide (Ala–Trp–Lys–Leu–Phe–Asp–Asp–Gly–Val)	36
		Ethanol	Nonprotein amino acid (cycasthioamide and cycasindene)	37
			b-Nmethylamino-L-alanine (BMAA)	38
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

Table 3: Pharmacological activities of *Cycas revoluta*.

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			2
3	Leaves	Antioxidant	1. Hydro-alcohlic (More potent) 2. Methanolic		41
			Hydrous		25
			Methanol, ethanol and ethyl acetate		42
		Antidiabetic			43
		Antimicrobial	Methanol and ethanol	*S. aureus* , *B. subtilis* , *P. aeruginosa* , *E. coli, K. pneumoniae* and *S. typhimurium.*	44
			Ethanolic	*K. pneumonia*	45
		Antibacterial	1. Hydro-alcohlic (More potent) 2. Methanolic	*E.coli, Klebsiella pneumoniae* and *Saccharomyces cerevisae*	41
			Hydro-alcoholic and chloroformic extracts	*Lactobacillus plantarum, Micrococcus luteus* and *Salmonella abony*	23
			Methanol, ethanol and ethyl acetate	*E. coli, S. aureaus, P. aeruginosa, S. typhimurium, K. pneumonia* and *B. subtilis*	42
		Moderate antibacterial	Chloroform	Staphylococcus aureus	28
		Antioxidant	Methanolic and its Methylene chloride and ethyl acetate fractions		30
4	Leaflet	Cytotoxic	Methanolic and its fractions 1.Ethyl acetate (highest inhibitory activity) 2. n-butanol 3.Methylene chloride	MCF7 cell line	30
			Methanolic and its fraction 1.n-butanol (most active) 2.Pt ether 3.Methylene chloride	HepG2 cell line	30
		Antileishmanial activity	Methanolic	*L. donavani*	29
		Antifungal	Methanolic	*Candida albicans* ,*Candida glabrata* , *Candida krusei* ,*Cryptococcus neoformans Aspergillus fumigatus*	29
5	Leaf rachis	Antifungal		*Trichoderma viride*	27
6	Female Cone	Antimicrobial	Chloroformic	*E. coli, Lactobacillus plantarum, Micrococcus luteus, Salmonellaabony, Candida albicans, Aspergillus niger* and *Methicillin resistant strains of Staphylococcus aureus (MRSA).*	23
7	Male cone	Anticancer	Methanolic	*Colon cancer*	46
8	ovule	Antibacterial	Methanolic extract	*E.coli, Pseudomonas, Staphlyococcus aureus, Bacillus cerius*	47
9	Seeds	Antirheumatic			2
		Expectorant, and tonic			2
		Antibacterial	Phosphate buffered Saline	*S. epidermidis, Bacillus subtilis, Pseudomonas aeruginosa,* and *Escherichia coli*	36
		Antimicrobial		*Erwinia carotovora subsp. carotovora, Agrobacterium rhizogenes, Agrobacterium radiobacter, Clavibacterium michiganensis subsp. michiganensis, Curtobacterium flaccum faciens pv. oortii, Geotrichum candidum*	48
		Anticancer	phosphate-buffered saline	human epidermoid cancer (Hep2) and colon carcinoma cells (HCT15)	36

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, flavonoid, cycasin, lectin, peptides, biflavonoid are present in this plant hence it shows several pharmacological activities such as antioxidant, anticancer, antileshamanian, antifungal, antibacterial and antimicrobial etc.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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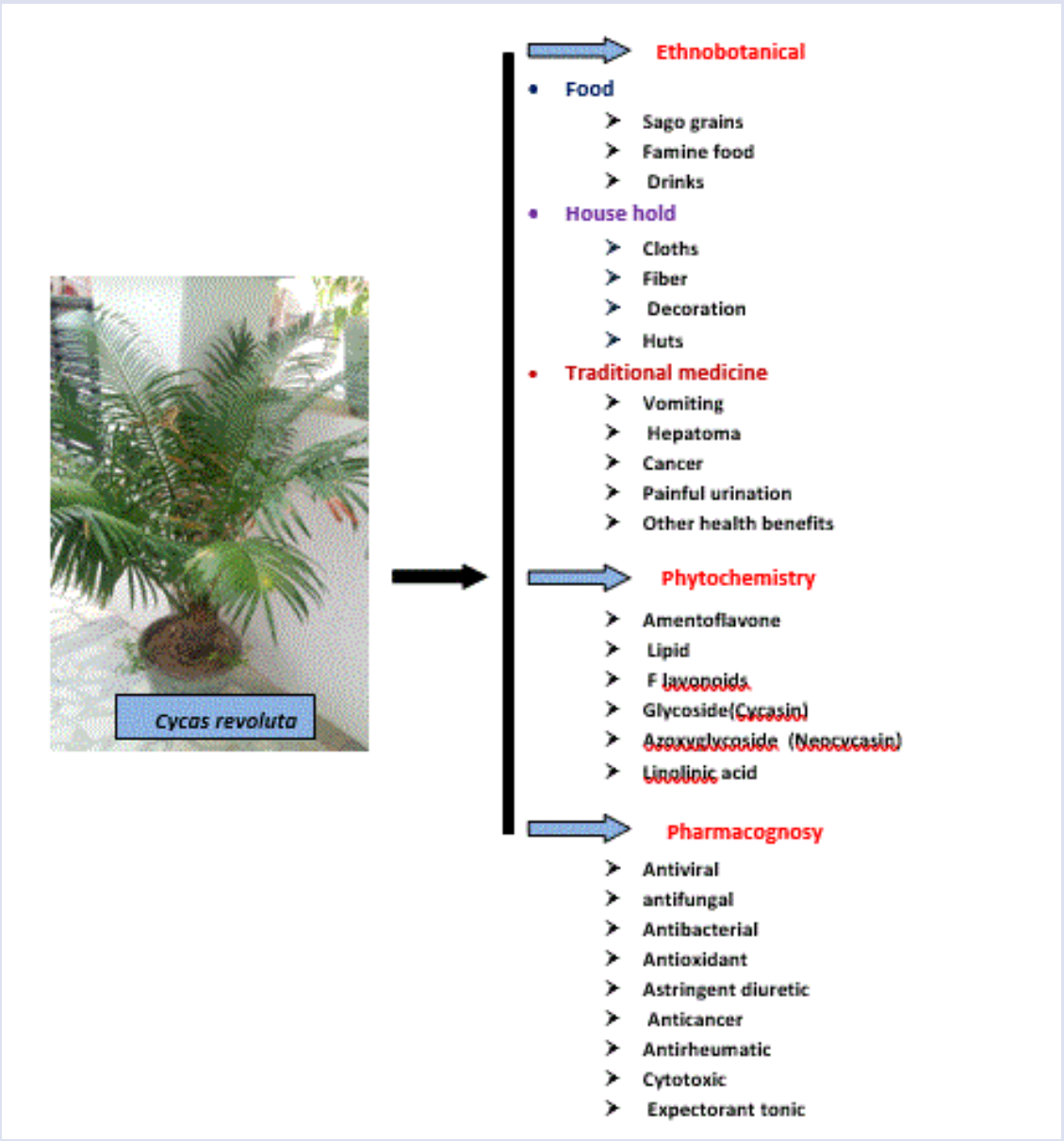
GRAPHICAL ABSTRACT



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