



Review Article

Nutritional composition, Taxonomical and phytoremediation status of Duckweed (*Wolffia*): Review

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Abstract: *Wolffia* are the crucial in decline of a flowering plant having tiny, rootless spheres in 1 mm length (or less). *Wolffia* is commonly known as Watermeal because it look like small particles over the water. 5 species of *Wolffia* are found in Western United States, while 11 species all over world. Being taken from pond to pond on the feet of water fowl (tucked neatly under the ducks' bodies during flight), might describe the distribution of few *Wolffia* species. In the South eastern part of US, there are evidence of *Wolffia* plant being taken from tornado, and they had been reported in the water of melted hailstones. Our review were focus on the Nutritional aspects, Taxonomy, Phytoremediation of heavy metal and uses of different species of *Wolffia* plant.

Keywords: *Wolffia*, Aquatic Plant, *Araceae*

Introduction

Family of duckweed (Lemnaceae) contains thirty eight species of minute flowering plants, floating at the surface of ponds, swamps and quiet streams. They're distributed throughout the planet, significantly in heat temperate and tropical regions. They're greatly reduced flowering plants, while not leaves or stems, and with solely the remnants of plant tissue in some species. The family contains 5 genera, based mostly upon the presence or absence of roots and therefore the form of their plant body. Some botanists see the plant body as a "frond" or "thallus," however these terms don't seem to be applicable as a result of the plant body isn't homologous to a leaf or to the bodies of fungi and alga.

Wolffia is a genus of nine to eleven species that embrace on Earth the littlest flowering plants. Usually known as duckweed or water plant, *Wolffia* give specks of Indian meal buoyant on the water. Species of *Wolffia* square measure floating free thalli, in experienced or chromatic, and while not roots. The flower is made during a depression on the highest surface of the plant body. Having 1 stamen and Pistil. People typically float along in pairs or type floating mats with connected plants, like genus *Spirodela* and *Lemna* species. Most species have a awfully wide distribution across many continents. *Wolffia* species square measure composed of regarding four-hundredth super molecule on a dry-matter basis, regarding identical because the soybean, creating them a high-protein food for human. They traditionally been collect from the water and devoured as a vegetable in abundant of Asia. The genus was 1st recorded in New Zealand by Ruth Mason.

Classification: Genus *Wolffia* belongs to Kingdom Plantae, Division Angiosperms, Order Alismatales, Subfamily Lemnoideae, Family Araceae

Leaf: No true leaves. The leaf-like body is called a thallus. Water-meal: roundish, thick, thallus up to 1.3 mm in diameter. Mud-midget: thin, sickle-shaped thallus up to 9 mm long and 1.5 mm wide, plants tend to form star-shaped clusters.

Stem: None.

Flower: Tiny, rarely seen. Arises from a cavity on the upper surface of the thallus.

Fruit: Is is no coincidence that the world's smallest fruits are produced by the world's smallest flowering plants. These remarkable plants belong to the genus *Wolffia*, minute rootless plants of the duckweed family (Lemnaceae) that float at the surface of quiet streams and ponds. In technical botanical terms, the fruit of these tiny aquatic plants is indehiscent, bladderlike, one-seeded and is often referred to as a utricle. Balloon-like fruit (utricle) contains a tiny (0.5 mm) smooth seed.

Root: None.

Distribution: The different species are found throughout much of the temperate and subtropical regions of the world. Mud midget may have been introduced to Washington from the southern U.S., but may not be winter hardy.

Phytoremediation by using Duckweed *Wolffia*:

Phytoremediation is identified to be a treatment system which fulfilling those criteria. It is relatively low cost to maintain since it is solar-driven and no complex containment system needed. It is cheaper than conventional treatment methods that rely on electricity, pumping, aeration or chemicals additions and usually need large concrete or steel vessels. It is also the less injurious method as it uses organisms which are naturally occurring and preserves environment in more natural way, and it is some more aesthetically pleasing. Significant amounts of pollutants eg. phosphate, ammonia and etc. can be efficiently reduced by phytoremediation

***Wolffia* as a waste water treatment:** For treatment of waste water coming out from the industrie, wolffia has been used from last two decades (Oron *et al.*, 1988). Because of its capability to grow in any temperature, any pH and nutrient level it is mostly used for treatment of waste water (Landolt and Kandeler 1987). Duckweed also diminished the growth of algae in pond as well as reduces nitrogen through NH₃ uptake and denitrification (Alaerts *et al.*, 1996; Hammouda *et al.*, 1995). Duckweeds, like

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different plants, absorb nutrients from their surrounding environment (Landesman, 2000). This capability has been exploited to put off surplus nutrients from swine lagoon effluents (Cheng *et al.*, 2002b). The developing flowers can then be harvested to eliminate surplus nitrogen and phosphorus. but, the utility of duckweed in recuperation (Cheng *et al.*, 2002a) and removal of nitrogen and phosphorus in swine lagoon water was discovered to be concern to the water concentrations and seasonal climate because the primary mechanism is assimilation of those vitamins in environment; consequently, the suitable mild depth and leading temperature are key parameters for duckweed in elimination of surplus nutrients (Cheng *et al.*, 2002b), and duckweed prefers to take up NH_4^+ than NO_3^- by way of each roots and fronds (Fang *et al.*, 2007).

Wolffia as a Means of Removing Heavy Metal: Heavy metals are easily accrued and transported in aquatic surroundings inside the form of dissolved or strong wastes from home, business, and agricultural runoff. Heavy metal contamination in environment can be cost-effectively removed by phytoremediation. Such a technology is most suitable for developing countries (Ghosh and Singh 2005). Garg and Chandra (1992) addressed that the plants are sensitive to the variations in metal concentration and are capable of high metal enrichment at very low ambient concentration of the metals.

Mineral composition in Fresh and Dry Duckweed

S.No.	Minerals	Fresh (Bui Xuan Men <i>et al.</i> , 1995; Ly <i>et al.</i> , 2002; Negesse <i>et al.</i> , 2009)	Dry (Muztar <i>et al.</i> , 1976; Bui Huy Nhu Phuc, 2006)
1.	Ca	23.3 g/kg DM	20.3 g/kg DM
2.	P	5.7 g/kg DM	5.2 g/kg DM
3.	K	42.9 g/kg DM	-
4.	Na	1.4 g/kg DM	-
5.	Mg	1723 mg/kg DM	241 mg/kg DM
6.	Zn	75 mg/kg DM	167 mg/kg DM
7.	Cu	20 mg/kg DM	2 mg/kg DM
8.	Fe	0 mg/kg DM	5405 mg/kg DM

Species & Uses of *Wolffia*:

***Wolffia angusta*:** *W. angusta* is a species of flowering plant belonging to family Araceae. (Roskov *et al.*, 2014) Recorded as the smallest flowering plant by Guinness Book of World measuring 0.6 millimetres (0.0236 in) in length and 0.33 mm (0.013 in) in width. (Young, 1997) However, more recently *W. globosa* has been describe as the smallest, at 0.1–0.2 mm (0.004–0.008 in) in diameter (Lock, 2013).

***Wolffia arthiza*:** *Wolffia arthiza* could be a species of phanerogam identified by the common names immaculate duckweed and unsettled hydrophytic plant, happiness to the Araceae family, a family wealthy in water-loving species, reminiscent of Arum and water cabbage. it's the littlest tracheophyte on Earth (Pietryczuk, 2009; Pan and Chen, 1979; Czerpak *et al.*, 2004) it's native to Europe, Africa, and elements of Asia, and it's gift in alternative elements of the globe as a naturalized species. it's Associate in Nursing hydrophytic plant that grows in quiet water bodies reminiscent of ponds. The inexperienced a part of the plant, the frond, could be a sphere mensuration concerning one millimeter wide, however with a flat prime that floats at the water's surface. it's a couple of parallel rows of stomata (Pan and Chen, 1979). There's no root.

The plant produces a moment flower totally equipped with one reproductive structure and one reproductive structure. It usually multiplies by vegetative copy, however, with the rounded half budding off into a replacement individual (Pan and subgenus Chen, 1979). In cooler conditions the plant becomes dormant and sinks to the bed of the water body to overwinter as a turion (Al Khateeb) The plant could be a mixotroph which will turn out its own energy by chemical change or absorb it from the atmosphere within the style of dissolved carbon (Czerpak *et al.*, 2004)

This tiny plant may be a nutrient food. Its inexperienced half is regarding four-hundredth macromolecule by dry weight and its turion is regarding four-hundredth starch (Fujita, 1999; Czerpak and Szamrej, 2003). It contains several amino acids vital to the human diet, comparatively massive amounts of dietary minerals and trace components equivalent to metallic element, magnesium, and zinc, and antipernicious anemia factor (Czerpak and Szamrej, 2003) it's long been used as an inexpensive food supply in Myanmar, Laos, and Asian nation, wherever it's referred to as khai-nam ("eggs of the water") (Bhanthumnavin and McGarry, 1971) The plant is prolific in its copy, growing in floating mats which will be harvested each three to four days; it's been shown to double its population in not up to four days in vitro (National Academy of Sciences, 1976).

It is additionally helpful as a type of agricultural and municipal water treatment (Körner *et al.*, 2003). It is placed in effluent from black tiger shrimp farms to soak up and metabolise pollutants (Suppadit *et al.*, 2008). The plants grow quickly and take up massive amounts of element and phosphorus from the water (Fujita *et al.*, 1999). The plants that grow within the waste material will then be used as feed for animals, equivalent to carp (Naskar *et al.*, 1986) Nile River fish genus (Chareontesprait and Jiwayam. 2001), and chickens (Al Khateeb).

Wolffia australiana:

- Distribution:** Indigenous. North, South and Chatham Islands. Found throughout the Southern Hemisphere but exact distribution not clear
- Habitat:** Coastal to lower montane (up to 400 m a.s.l.) in still, fertile, water in sunny situations. Often found in association with *Lemna minor* L., *Landoltia punctata* (G.Mey.) Les et D.J.Crawford, *Azolla filiculoides* Lam., *Ricciocarpos natans* (L.) Corda and *Riccia fluitans* L. Easily overlooked.
- Features:** Bright green, minute aquatic summer-green herb without roots. Platelets 0.3-1 mm long, bearing one vegetative bud per platelet, ellipsoidal, dorsal surface weakly convex, the central green part merging into a colourless rounded shoulder; submerged portion much larger than that above water, pale, loosely cellular, more or less semi-circular in side view but laterally compressed. Inflorescence in a cavity opening on upper platelet surface; bearing one male and one female flower united without spathe. Ovule 1. Fruit spherical. Seed smooth with prominent operculum.
- Similar Taxa:** None. Could be confused with *Lemna* and *Landlotia* from which it differs by its much smaller size, absence of roots, uniformly green colour

- without red or purple pigmentation, and by the platelets bearing only one vegetative bud.
- e) **Flowering:** November – February
- f) **Fruiting:** December – April
- g) **Propagation Technique:** Easily grown in a suitable pond, pool or aquarium. During winter it sinks to the bottom sediment, and becomes dormant, returning to surface during warmer weather in late spring and summer.

Wolffia borealis: *Wolffia borealis* could be a species of seed plant familiar by the common name northern duckweed. It's native to North America together with sections of North American country and also the US. It grows in mats on the surface of calm water bodies, akin to ponds. It's a really small plant with no leaves, stems, or roots. The inexperienced half is up to 1.2 millimeters long with one rounded finish and one pointed finish. On the planate high of the plant could be a single reproductive structure and reproductive structure. Like alternative *Wolffia*, it's edible and makes a alimental food.

Wolffia brasiliensis: *Wolffia brasiliensis* is a species of flowering plant known by the common name Brazilian watermeal. This tiny plant is a floating aquatic and a summer annual. Its main body is referred to as a frond (or thallus). An individual frond is 0.5-1.5 mm. in length (usually 1.0 mm. or less), ovoid and slightly compressed in shape, smooth along the outer margins, and hairless; both ends of the frond are rounded, rather than acute. Each frond is about 1.0-1.5 times as long as it is across. The upper part of the frond is medium to dark green, while the lower part is light green to transparent. The frond has no conspicuous veins. Embedded within the frond, there are tiny cavities of air that enable it to float on the surface of water. There are also pigment cells along the upper part of the frond that resemble tiny brown dots in dried-out herbarium specimens.

The upper surface of the frond is flat along the margins, but slowly rises toward the center, where a single papule (or papilla) is located. This papule resembles a small conical bump. The lower surface of the frond is convex, rather than flat. It is native to North and South America, wherever it grows in mats on the surface of calm water bodies, appreciate ponds. It's a really little plant with no leaves, stems, or roots. The inexperienced half is up to 1.2 millimeters long with a flat surface with a bump within the center.

Wolffia columbiana: *Columbiana* watermeal is a perennial aquatic plant in the family of Duckweed (Lemnaceae) (Britton & Brown, 1913; USDA Plants Profile). Plant is distributed widely throughout South, Central, and North America, and also occurs in Curaçao (Flora of North America, 2009).

Wolffia cylindracea: This name is the accepted name of a species in the genus *Wolffia* (family *Araceae*). The record derives from WCSP (data supplied on 2012-03-23) which reports it as an accepted name (record 214827) with original publication details: *Lemnac. 123 1868*.

Wolffia globosa: Khai Nam is one of the smallest flowering plants in the world. An aquatic plant, it floats upon the surface of still or slowly flowing water (Facciola, 1990; Huxley, 1992). The plant is cultivated as a vegetable in Burma, Laos and Thailand (Cornucopia - A

Source Book of Edible Plants, 1990). It has been recommended for commercial cultivation, especially in tropical areas, because of its rapid multiplication and high nutritional value (Facciola, 1990). Plant densities of over two million plants per square metre have been found (Diggs, 1999). Although no specific mention has been seen for this species, it belongs to a family where most of the members contain calcium oxalate crystals. This substance is toxic fresh and, if eaten, makes the mouth, tongue and throat feel as if hundreds of small needles are digging in to them. However, calcium oxalate is easily broken down either by thoroughly cooking the plant or by fully drying it and, in either of these states, it is safe to eat the plant. People with a tendency to rheumatism, arthritis, gout, kidney stones and hyperacidity should take especial caution if including this plant in their diet (Bown, 1995)

Edible Uses: Leaves - cooked. An excellent flavour, they taste somewhat like a sweet cabbage. The leaves are very nutritious, containing about 20% protein, 44% carbohydrate, 5% fat and are rich in vitamins A, B2, B6, C and nicotinic acid.

Wolffia microscopica: This is perhaps one of the most bizarre of all *Wolffia* species, and certainly one of the strangest flowering plants on earth. Its native range appears to be subtropical and tropical India. The plant body is orbicular (rounded) to polygonal, with a flat upper surface and a lower side that tapers into a conical appendage that points down into the water. This appendage resembles a short root, but it apparently does not serve the function of a true root. The unusual plant superficially resembles a minute, green, golf tee floating upright on the water surface. No other *Wolffia* species has this unusual shape. In addition to its unique shape, *W. microscopica* also has one of the most rapid rates of vegetative reproduction. It can produce a smaller daughter plant in its basal reproductive pouch by budding every 30-36 hours. One plant could theoretically give rise to about one nonillion plants (1 followed by 30 zeros) in four months. This represents a spherical volume of *Wolffia* plants roughly equal to the size of the earth. A flowering (*Wolffia microscopica*) next to the tip of a sewing needle. The unusual "golf tee" shape is unique among all *Wolffia* species. A small male organ (stamen) can be seen protruding from the upper (expanded) side of the plant body.

Conclusion

There is thus the need of educating people about the *Wolffia Spp.* and also raise the awareness in pharmacologists and the researchers so that a better deed can be done in the society through medical values. Writing reviews along with continuous research on the various aspects of the particular species, thereby increasing the interest of various research communities is the only way to create medicinal progress with *Wolffia Spp.*

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