ACADEMICIA: An International Multidisciplinary Research Journal
ISSN: 2249-7137 Vol. 11, Issue 12, December 2021 SJIF 2021 = 7.492
A peer reviewed journal

# AN OVERVIEW ON THE BIOLOGICAL FAMILY AND THE BENEFITS OF LOTUS

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**DOI: 10.5958/2249-7137.2021.02631.8**

## ABSTRACT

*Lotus is an aquatic perennial basal eudicot that belongs to a tiny family with just one genus and two species. It is a significant horticultural plant that has been extensively utilized, particularly in Southeast Asia, for decorative, nutritional, and medicinal purposes. The lotus has recently gotten a lot of attention from the scientific community. A growing number of academic articles devoted to it have been published, shedding insight on the species' secrets. We examined the most recent research on the lotus, including phylogeny, genetics, and the molecular processes behind its distinctive characteristics, as well as its economically significant qualities. Meanwhile, existing limits in lotus research were addressed, and possible future directions were suggested. With the production of germplasm suited for laboratory operation and the construction of a regeneration and transformation system, we think the lotus will become an important model plant in horticulture.*

**KEYWORDS:** *Lotus, Genomics, Medicine, Molecular, Phylogeny.*

## 1. INTRODUCTION

Lotus is an aquatic perennial plant. It is a member of the Nelumbonaceae family, which has just one genus, Mulumba, and two species, Mulumba nucifera Geert. And Mulumbaluteal Pear. Which are known as Asian and American lotus, respectively. Lotus refers to Asian lotus, which is found predominantly in Asia and northern Oceania, while American lotus is found mostly in eastern and southern North America, as well as northern South America. These two species have different exterior morphologies, such as petal color and form, leaf shape, and plant size, due to their separation by the Pacific Ocean. Despite this, they have the same chromosomal number. And have a similar life style, with each generation having a life span of approximately five months. Crossing these two species may result in a generation that is completely sterile. Despite the fact that there are only two species of lotus in taxonomy, there are many germplasms all over the globe with diverse genetic origins and phenotypes, particularly in Asia. Furthermore, the lotus is a primitive eudicot, making it a crucial species in plant phylogenetic and evolution research. Because of its religious importance in Buddhism and Hinduism, the Asian lotus is also known as holy lotus. In Chinese traditional culture, it is an excellent emblem. Sacred lotus is a popular decorative plant because of all of these characteristics. It's also a popular food and traditional medicinal plant in Southeast Asia, having a high economic worth. With thousands of

years of lotus cultivation and breeding history, China is considered one of the main hubs for lotus cultivation and breeding[1].

*1.1. Phylogeny and Genomic Studies*:

Lotus is classified as a member of the genus Mulumba, which is the sole genus in the Nelumbonaceae family. Nelumbonaceae has been attributed to Cretaceous remains. According to the analysis of these fossils, the Nelumbonaceae family has a history of more than. Ma years and exhibits significant morphological stability. It took a long time to figure out how to classify lotuses in taxonomy. In the previous classification system, Mulumba was considered one genus of the Nymphaeaceae family because of its superficial similarities in flowers and vegetative body with the waterlily. The Nelumbonaceae family was acknowledged under the Cronquist classification, although it was nonetheless put in the Nymphaeales order. The Nelumbonaceae family was given its own order, Nelumbonales, in both the Dahlgren and Thorne systems.

Takhtajanseparated Nelumbonaceae from Nymphaeales and put them in the Nelumbonidae subclass. The Angiosperm Phylogeny Group. Has placed it in the basal eudicot order of Proteases, which is outside of the core eudicots, based on growing molecular evidence. Except for Nelumbonaceae, Proteases includes three additional families: Platanaceae, Proteaceae, and Salicaceae, the latter two being the closest relatives of the lotus and consisting mostly of shrubs and woody trees. Implying that the lotus is a terrestrial plant adapted to water conditions. On the USDA website. The Nelumbonaceae family is still listed as part of the Nymphaeales order. Furthermore, investigations have shown that the gene expression patterns of Nymphaea and Mulumba floral organs are very similar. The evolutionary convergences between Nymphaeales and the lotus would be fascinating to study[2].

*1.2. Unique Properties of Lotus:*

Lotus contains not just the typical characteristics of an aquatic plant, but also certain distinctive characteristics that set it apart from other plant species. Seed lifespan, leaf ultra-hydrophobicity, and floral thermoregulation are among these characteristics. Understanding the processes that contribute to the development of these distinct characteristics is critical not only for fundamental plant biology, but also for bionics applications. The lifespan of the lotus fruit is well-known. It has been claimed that lotus fruits buried underground for over.in China's northeast may still germinate. Understanding the fundamental process of lotus seed lifespan may help improve seed storage in agriculture, as well as human health care. Floral organ thermogenesis, which occurs independently at the receptacle, stamen, and petal, is another unique characteristic of the lotus.

This feature was discovered in the floral organs as a consequence of a cyanide-resistant alternative oxidase pathway, which sparked a flurry of research into alternative oxidases.And plant uncoupling mitochondrial proteins. This thermogenic characteristic seems to be biologically essential for lotus sexual reproduction by attracting insect pollinators. According to studies, the produced heat may either offer a warm habitat for thermo-sensitive pollinators or assist in the production of volatile chemicals that attract flying insects, mostly beetles. After a thesis, there is no need to attract pollinators, and the primary role of the floral organs, particularly the receptacle, switches to photosynthesis. Exploring the mechanism that regulates this kind of metabolic shift will be crucial[3].

*1.3. Genetic and Molecular Studies on the Horticultural Traits of the Lotus:*

As previously said, a lotus is a popular decorative, vegetable, and medicinal plant with a wide range of practical applications, resulting in the classification of three kinds of lotus: flower, seed, and rhizome lotus. Each lotus species has a wide range of phenotypes. Which offer appropriate material for breeding and further research on many characteristics. A number of recent research have focused on the genetic and molecular processes underpinning the development of various lotus flower, seed, and rhizome characteristics. These characteristics may have a significant role in determining the lotus' economic worth, making them the most important elements to consider while breeding it. Several genetic maps have been created by crossing different germplasms with differential phenotypes in some of the economic characteristics, and these genetic maps have been used to generate a number of molecular markers linked with the target attributes, including. Meanwhile, SNPs and Indwells were found in abundance in whole genome re-sequencing on wild germplasm. These data, when combined, will definitely aid lotus breeding[4].

*1.4. The Flower of Lotus:*

The lotus flower is one of China's top ten traditional renowned flowers, and it is also India and Vietnam's national flower. It is extensively grown for its aesthetic value, which is mainly because to its beautiful color and varied form and shape[5]. Flower color and form are the two most important elements in determining the aesthetic value of ornamental plants. The three primary hues of lotus petals are white, red, and yellow, with the first two colors seen exclusively in Asian lotus and the latter in American lotus. Many cultivars with mixed hues have been developed via breeding and artificial selection in order to increase their aesthetic value. The concentrations of carotenoids and anthocyanins, respectively, are the primary determinants of yellow and red color, according to a large-scale study of the pigment composition of various genotypes. Anthocyanin biosynthesis regulation is comparable in lotus and Arabidopsis, according to a genome-wide study of the MYB gene family.And overexpression of.in Arabidopsis resulted in anthocyanin accumulation in immature seeds and flower stalks. Despite this resemblance, a comparative proteomics analysis of white and red cultivars revealed that the lack of anthocyanin production in the white flower lotus may be due to the expression of the ANS gene.

Further investigation revealed that the two cultivars had distinct amounts of methylation in the promoter regions of the ANS gene, indicating epigenetic control of this gene's expression. However, the gene that causes the red and white lotus cultivars to have differing levels of methylation on the promoter of the ANS gene is yet unclear. Furthermore, certain cultivars have a genetically consistent speckled hue. Which is yet unknown. Exploring the mechanism behind the control of spotted color in lotus will be crucial not only for flower lotus breeding, but also for expanding our understanding of plant flower coloring[6].

*1.5. Rhizome and Seeds:*

Because of its edible rhizome and seeds, lotus is not only an attractive plant, but also a food, as previously stated. Lotus has a subterranean stem that has been morphologically changed. The subterranean stem of the temperate ecotype is expanded in fall, which is known as rhizome. The rhizome is a popular edible vegetable because it includes a lot of carbohydrates, proteins, and vitamins. The economic worth of a lotus rhizome is mainly determined by its size. Furthermore,

the larger rhizome may aid the lotus in surviving winter during its bud hibernation, as well as providing substrates and energy for asexual propagation. This process is comparable to the tuberization of potatoes, which has been shown to be controlled by a complex genetic network.

Because it is a differentiating characteristic between temperate and tropical lotus, it may aid in understanding the lotus' development and domestication. In a lotus, rhizome expansion seems to be closely linked to blooming. The expansion usually happens after blooming. Genetic and transcriptome research focused on the expansion of this rhizome have been performed with the goal of improving its output in agricultural agriculture. Furthermore, a comparative transcriptome study was performed between two lotus germplasms with differing seed size and seed number per seedpod characteristics. Seed yield, like rhizome yield, is a quantitative characteristic that needs more genetic research. Meanwhile, because of its therapeutic value, a thorough study of its metabolites throughout seed growth is required[7].

### *1.6. Secondary Metabolites and Medicinal Usage of Lotus:*

Lotus is a traditional plant with therapeutic properties in almost every tissue. For almost a thousand years, it has been utilized as a traditional Chinese medication. This may be due to its high concentration of secondary metabolites such as flavonoids, phenolic acids, and alkaloids. The technique for extracting these metabolites from various tissues of the lotus has been studied extensively. In the meanwhile, the distributions of several secondary metabolites in various lotus tissues have been studied. Furthermore, these proven techniques. Were used to evaluate lotus germplasm from various sources, which aided in the screening of germplasm with a high concentration of particular secondary metabolites. These potential germplasms may be utilized for breeding or further research into the production of several compounds in the lotus. In addition, the therapeutic potential of several lotus secondary metabolites was investigated. However, the precise chemicals that work in each therapeutic application remain unclear, which seems to be a common problem in traditional Chinese medicine. The lotus leaf, in particular, is an essential traditional Chinese herbal medicine that has long been used to regulate blood lipids and treat hyperlipidemia. It has been more popular in China as a weight-loss tea to lower cholesterol levels in the human body during the past decade. Alkaloids are the most abundant bioactive chemicals in lotus leaves, with luciferin and N-nornuciferine being the most abundant. Several transcriptomic studies were conducted to evaluate the biosynthesis pathway of alkaloids and its regulation in lotus leaf, which revealed that a benzylisoquinoline alkaloids. Biosynthetic pathway and its transcriptional regulation differ in high BIAs lotus compared to low BIAs lotus. Based on sequence similarity research, many genes encoding enzymes implicated in the BIA biosynthesis pathway were suggested. To get a complete understanding of the production of these bioactive chemicals, further functional study of these genes will be required[8].

### *1.7. Studies on the Establishment of Lotus Regeneration and Transformation System:*

It may be required to create a transformation system in order to study the roles of various genes in the lotus as a model horticulture plant. A research was performed to stimulate the development of a callus from several lotus explants, in which a somatic embryo was grown in an appropriate medium containing a mixture of different growth regulators. A proteomic study was performed to determine the main proteins that may be important for the induction of callus from growing cotyledon in order to get a better understanding. It has also been effective to induce the

development of a shoot directly from the bud. Various research to change the lotus have been performed based on this approach.

It seems that a particle bombardment device with a. vector may effectively convert the induced shoot from the embryo apical bud[9]. The anti-sense of two anthocyanin biosynthesis genes, dihydroflavonol. reductase.and Chaconne synthase. Was also successful using this approach? Except for the Thai group, there have been no other successful experiments on the metamorphosis of the lotus, despite the fact that many academics are working on it. It seems that repeatability and effectiveness of the transformation, as well as the selection of a suitable cultivar, are still issues[10].

## 2. DISCUSSION

The Lotus blossom is a symbol of purity, enlightenment, self-regeneration, and rebirth in many civilizations, particularly in eastern faiths. Its features are a great parallel for the human condition: the Lotus produces the most beautiful bloom even when its roots are in the dirtiest waters. The Lotus. is India's national flower. It is a holy flower that has a special place in ancient Indian art and mythology, and has served as an auspicious emblem of Indian culture from the dawn of time. The lotus is both a sign of heavenly perfection and a representation of what is divine or eternal in mankind. The lotus is the symbol of the sun and fire gods. Vishnu is also known as the "Lotus-Eyed One. The aquatic world's gems are lilies. And Lotus. Water lily blooms and leaves are waxy and thick, while lotus flowers and leaves are thin and papery. Each leaf of a water lily has a distinct notch

## 3. CONCLUSION

Lotus is receiving increasing interest from the scientific community because to its importance in the everyday lives of people in South and East Asia, as well as in agricultural and therapeutic uses. There have been many research on virtually every element of this plant, including phylogeny and evolution, genomics, genetics and breeding, and therapeutic use. With the publication of its genome material, -omics and molecular genetics research focused on the plant's economic characteristics have risen to the fore, and will certainly have a significant impact on lotus breeding. Unfortunately, there are still certain constraints that hinder research on this species, particularly molecular biology research.

The first one may be the genome's assembly and annotation, which still needs to be enhanced. Second, in the scientific community, there is no widely recognized lotus cultivar or germplasm that is frequently utilized for fundamental biology research. Because of its genetic homozygosity, the sequenced germplasm ‘China Antique' may be an excellent choice. Finally, the poor effectiveness of the regeneration and transformation mechanism makes it difficult to conduct molecular genetic research on the lotus, which are necessary for studying gene function. The lotus plant's unpredictable development and lengthy life span are the fourth and final factors that restrict its cultivation in confined spaces. Through artificial selection, a number of cultivars with small plant architecture and short life span. were obtained in lotus, which are very popular in the ornamental market, and named ‘Wan Lain'. By crossing these bowl lotuses with ‘China Antique,' and then backcrossing breeding, germplasm with both small plant size and short life span could be obtained

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