REVIEW ARTICLE

# Molecular and physiological role of *Epipremnum aureum*

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*Epipremnum aureum* (Golden pothos) is a naturally variegated climbing vine that produces abundant yellow-marbled foliage. It is among the most popular tropical ornamental plant used as hanging basket crop. An insight has been provided about the different varieties of Golden pothos including Neon, Marble Queen, Jade Pothos and N Joy. This paper presents a critical review on botanical study and important characteristics of Golden pothos and special emphasis has been provided on variegated leaves and chloroplast biogenesis explaining the important genes involved during the process and various proteins associated with it. Studies have been included comprising the special features of *Epipremnum aureum* in phytoremediation for the removal of Cobalt and Cesium and in the purification of air against formaldehyde. The antimicrobial activity of roots and leaf extracts of *Epipremnum aureum* against many bacterial strains have been included. It also presents the antitermite activity of Golden pothos that can be harnessed for pest control.

**Key words:** Antimicrobial, antitermite, calcium oxalate, *Epipremnum aureum,* formaldehyde

## INTRODUCTION

*Epipremnum* comprises 15 speciesof slender to gigantic root-climbing lianes.[1] All these herbaceous evergreens are native to South East Asia and Solomon islands.[2] Variegated clones of *E. aureum* (Linden and Andre) G.S. Bunting are extremely popular as cultivated plants worldwide, perhaps constituting the most commonly cultivated aroid, and the golden variegated form of this species is frequently met with as an escape from horticulture throughout the tropics.[3] Plants used for interiorscape purposes such as pedestal plants, totems, hanging baskets, dish gardens and small desk plants usually have heart-shaped leaves that rarely exceed 6 inches in length.

## DESCRIPTION

*Epipremnum aureum* is synonymous with Golden pothos, *Pothos aureuss, Scindapsus aureus, Raphidophora aurea,* devil's ivy, hunter's robe, ivy arum, money plant, silver vine, Solomon Islands ivy and taro vine. Golden pothos is also known as devil's ivy as it stays green even when kept in the dark. Its' classification is shown in Table 1.

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### Other Species of *Epipremnum*

- *Epipremnum amplissimum* (Schott) Engl
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- *Epipremnum carolinense* Volkens
- *Epipremnum ceramense* (Engl. and K.Krause) Alderw
- *Epipremnum dahlii* Engl
- *Epipremnum falcifolium* Engl.
- *Epipremnum giganteum* (Roxb.) Schott
- *Epipremnum meeboldii* K.Krause
- *Epipremnum moluccanum* Schott
- *Epipremnum moszkowskii* K.Krause
- *Epipremnum nobile* (Schott) Engl
- *Epipremnum obtusum* Engl. and K.Krause
- *Epipremnum papuanum* Alderw
- *Epipremnum pinnatum* (L.) Engl
- *Epipremnum silvaticum* Alderw.

### Varieties of *Epipremnum Aureum*

*Epipremnum aureum* (L.) Engl. comprises several varieties as shown in Table 2.

### Botanical Study

Botanical description of Golden pothos is shown in Table 3.

## SPECIAL FEATURES OF *EPIPREMNUM AUREUM*

### Chloroplast Biogenesis

Variegated plants are an ideal model for the study of chloroplast biogenesis as shown in Figure 1, because they have both green and white/yellow sectors on the same leaf, which can be used to compare differential gene expression directly and also for protein profiling

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**Table 1: Classification of *Epipremnum aureum***

| | |
|---|---|
| Kingdom | Plantae |
| Division | Angiosperms |
| Unranked | Monocots |
| Order | Alismatales |
| Family | Araceae |
| Subfamily | Monsteroideae |
| Tribe | Monstereae |
| Genus | *Epipremnum* |
| Species | *E. aureum* |
| Binomial name | *Epipremnum aureum* (L.) Engl. |

**Table 2: *Epipremnum aureum* species with its varieties**

| Variety | Feature |
|---|---|
| *Epipremnum aureum* (L.) Engl. | Heart-shaped leaves with yellow or white variegation |
| *Epipremnum aureum* 'Neon' | Solid yellow-green leaves with no variegation |
| *Epipremnum aureum* 'Marble Queen' | Fine variegation in white colour |
| *Epipremnum aureum* 'Jade Pothos' | Unvariegated, dark green colour leaf |
| *Epipremnum aureum* 'N Joy' | Variegation and bumpy leaf texture |

**Table 3: Various parts of *Epipremnum aureum***

Plants: Young plants feature bright, waxy, heart-shaped green leaves (to 4" long) that are variegated with yellow or white. On large mature vines, however, the leaves become much larger (to 30" long) with deep lobes. *E. aureum* is an evergreen vine growing to 20-m (66 ft) tall, with stems up to 4 cm (2 in) in diameter

Leaves: Leaves are colourful and evergreen. They are alternate, heart-shaped, entire on juvenile plants, but irregularly pinnatifid on mature plants, up to 100-cm (39 in) long and 45-cm (18 in) broad [juvenile leaves much smaller, typically under 20-cm (8 in) long]

Flower: Pothos plants do not flower under greenhouse and flowering is seldom reported even within native habitats. The flowers are produced in a spathe up to 23-cm (9 in) long

Stem: This plant is easily propagated from stem cuttings. This plant produces trailing stems when it climbs up trees and these take root when they reach the ground and grow along it

Roots: In its native habitat, it climbs tree trunks by aerial rootlets and tumbles along the ground as a ground cover, reaching up to 40' or more in length

in order to understand the co-ordinate expression of nuclear and organelle genes during chloroplast biogenesis.[4,5] The viable cells that contain undifferentiated chloroplasts in the white/yellow sectors do not appear to interfere with proper chloroplast development in the green sectors. During examination of individual cells, only one type of plastid was observed in each cell, either normal chloroplasts or abnormal plastids. The leaf variegation phenotype may originate from different mechanisms that interact with chloroplast development.

Using complementary DNA suppression subtractive hybridisation (SSH) between regenerated pale yellow and green plants, nine downregulated and 18 upregulated genes in pale yellow plants have been isolated. Transcript abundance for EaZIP (*Epipremnum aureum* leucine zipper), a nuclear gene homologue of tobacco NTZIP and Arabidopsis CHL27, was reduced more than 4000-fold in qRT-PCR analysis. EaZIP encodes the Mg-protoporphyrin IX monomethyl ester cyclase, one of the key enzymes in the chlorophyll biosynthesis pathway. Examination of EaZIP expression in naturally variegated 'Golden Pothos' confirmed that EaZIP transcript levels were correlated with leaf chlorophyll contents, suggesting that this gene plays a major role in the loss of chlorophyll in the pale yellow sectors of *E. aureum* 'Golden Pothos'. Thus, EaZIP was identified as a factor that may contribute to the yellow sector formation.[6]

## Root Pressure

The roots of *Epipremnum aureum*, does not synthesise nicotine themselves but can take up exogenously fed nicotine as a xenobiotic as shown in Figure 2. The alkaloid is subsequently translocated to the leaves, via the xylem path, where it accumulates in the mesophyll up to levels comparable with nicotine-rich *Nicotiana* species.

The *Epipremnum* plants accept nicotine only up to a distinct level after which it reaches saturation about 10 days.

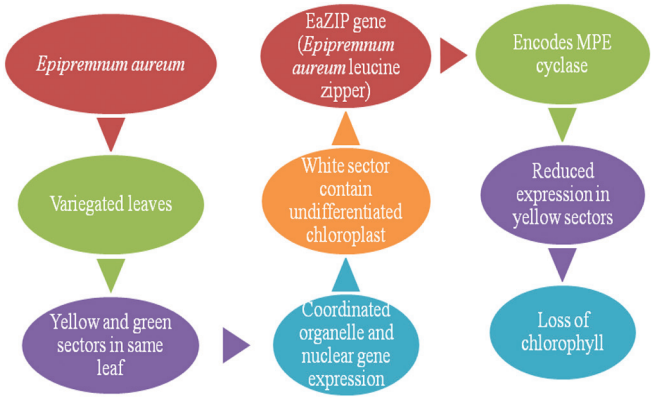


**Figure 1:** Chloroplast biogenesis in variegated leaf of *Epipremnum aureum*

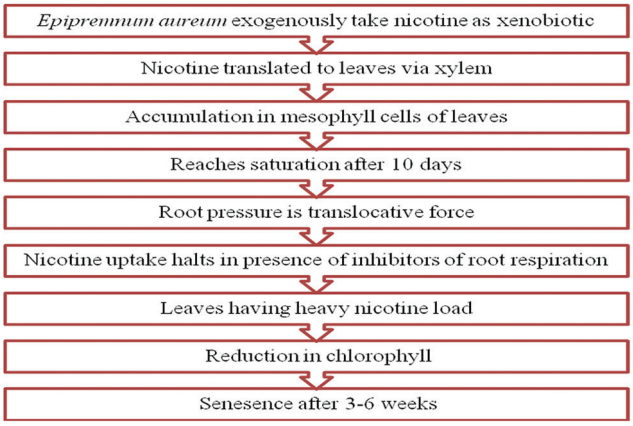


**Figure 2:** Mechanism of uptake, transport and storage of nicotine

All mature, non-senescent leaves accumulate the same amount of nicotine. By different experimental approaches, unequivocal evidence could be provided that root pressure is the 'translocative force' for nicotine transport in *E. aureum*. Under the influence of inhibitors of root respiration, nicotine uptake was halted slowly in case of oxygen deprivation and in case of cyanide, or it stopped very rapidly when CCCP, an uncoupler of mitochondrial ATP formation, was applied to the roots. Leaves, bearing a heavy 'nicotine load', showed symptoms of senescence only after 3-6 weeks, as indicated by a decline in the chlorophyll content, the chlorophyll a/b ratio, and the maximal quantum yield efficiency (Fv/Fm), and by an increase in catalase activity. This study has showed the mechanisms of uptake, transport and storage of nicotine as a xenobiotic.[7]

## MOLECULAR STUDIES CARRIED SO FAR

The genome size of *Epipremnum aureum* is 7815.39 (2C, Mbp), having 42.70% of GC content.[8] In response of formaldehyde, genes have been isolated from *Epipremnum aureum* using GeneFishing PCR. Immediate early gene was studied in response of formaldehyde. cDNA sequence for class II chitinase is generated. This gene is suggested to have a novel physiological role for chitinase in environment and carbon metabolism in plants.[9] In eukaryotes, formaldehyde dehydrogenase (FALDH) is playing role in formaldehyde metabolism. Its cDNA has been cloned from *Epipremnum aureum* and is capable of purifying gaseous formaldehyde. Studies have revealed that FALDH from Golden pothos in transgenic plants is more effective in removing formaldehydes compared with Arabidopsis and rice.[10]

## CHARACTERISTIC FUNCTIONAL ACTIVITIES OF EPIPREMNUM AUREUM

### Phytoremediation

Phytoremediation is a newly developed technology for treatment of low and intermediate level liquid radioactive wastes originated from the daily use of nuclear technologies in life. Studies have shown that *Epipremnum* can accumulate Co-60 and Cs-137 from solutions, both in the absence and presence of stable carriers and nutrient ions without apparent toxicity. Thus, for solutions in which conventional cleanup is unsuitable or expensive, *Epipremnum* might offer a method of Co-60 and Cs-137 accumulation.[11]

### Calming Effect

It was found that actively touching a leaf of natural pothos caused people to experience an unconscious calming response. This research supports the various previous studies that plants, nature and material of natural origin bring feelings of relaxation to people. The results of this experiment might have been different if leaves with various different surface types had been used and it is necessary to examine this further. This report offers a new framework for understanding the relationship between human beings and plants or nature.[12]

### In Cleaning Air Pollution

Formaldehyde is a major indoor air pollutant. Its removal from air can reduce the health risk of urban population. *Epipremnum aureum* is very effective plant is removing formaldehyde. It is very much suitable for garage since car vehicle exhaust contains formaldehyde. It has the capability to absorb and metabolise formaldehyde which is a major indoor pollutant. Study has been conducted on the removal of benzene by *Epipremnum aureum* as shown in Table 4.[13] These plants can also reduce benzene and trichloroethylene levels.[14]

### As Antimicrobial Agent

The plant exhibits broad spectrum antimicrobial activity against various pathogens. Leaves and aerial roots of the *E. aureum* have shown great potential of antimicrobial activity as shown in Table 5. Some of the plant extracts possess compounds with antimicrobial properties that can be further explored for antimicrobial activity.[15]

### Antitermites Activity

Studies show that 5% concentration of aerial root extract in ethanol shows antitermites activity in 5 minutes from 96 to 100% whereas *Epipremnum aureum* root extract in water has shown antitermites activity after 10 minutes. Thus, this plant can be cheaply harnessed in combating agricultural infections and can be used for pest control.[15]

## PROBLEMS

No serious insect or disease problems but care should be taken for fungal leaf spot and botrytis. Roots may rot in poorly drained soils and scale and mites may appear.

## CALCIUM OXALATE AND TOXICITY

All parts of the plant contain calcium oxalate crystals which may cause atopic dermatitis and serious reactions if chewed or swallowed as shown in Table 6. The plant is listed as "toxic to cats, toxic to dogs" by the American Society for the Prevention of Cruelty to Animals (ASPCA), because of the presence of insoluble raphides. Care should

**Table 4: Effect of *Epipremnum aureum* in cleaning air pollution**

| Plant species | Fumigation fashion | Chamber size | Volatile organic compound | Concentration level | Removal rate |
|---|---|---|---|---|---|
| *Epipremnum aureum* | Static fumigation | Cubic; 60×60×60 cm | Benzene | 25 ppmv | Less than 10% |

**Table 5: Antimicrobial effect of *Epipremnum aureum***

| Name of the plant | Parts used | Extract/ compound | Bacterial strain (zone of inhibition in mm) |
|---|---|---|---|
| *Epipremnum aureum* | Leaves | Ethanol | *E. coli* (16), *Micrococcusluteus* (14), *Bacillus subtilis* (20), *B. cereus* (13) |
| *Epipremnum aureum* | Roots | Water | *E .coli* (24), *Micrococcus luteus* (17) |
| | | Methanol | *Bacillus subtilis* (21) |
| | | Acetone | *B. cereus* (18) |

**Table 6: Toxic effect of *Epipremnum aureum***

| Plant species (family) | Common name | Primary toxicity | Xenobiotics | Class of xenobiotic |
|---|---|---|---|---|
| *Epipremnum aureum* (araceae) | Pothos | Dermatitis: Mechanical and cytotoxic | Oxalate raphides | Carboxylic acid |

be taken to ensure the plant is not consumed by house pets or children. Symptoms may include oral irritation, vomiting and difficulty in swallowing. The level of toxicity is generally mild to moderate. Handling plant may cause skin irritation or allergic reaction. Symptoms include burning and swelling of lips, mouth, tongue and throat, also diarrhoea whereas skin irritation occurs from frequent contact.[16]

## CONCLUSIONS

Study has been conducted at the molecular level of Golden pothos and it has been shown that EaZIP gene is the only differentially expressed gene which codes for MPE cyclase involved in chlorophyll biosynthesis. Thus, EaZIP gene is responsible for leaf variegation. Formaldehyde is a major contaminant in indoor air and *Epipremnum aureum* is known to absorb and metabolise gaseous formaldehyde. Phytoremediation of chemical air pollutants such as formaldehyde have also been reported by Pothos. Touching the leaves of this plant causes calming effects in humans. We have already achieved the results in the favour of plant leaves and aerial roots that have great antibacterial and antitermiteactivity.[15] The detail study of this plant at molecular level (characterisationof the compound) is under process in our lab.

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