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## Review Article

# Dragon Fruit (*Hylocereus* species) as a Potential CNS Modulator: Emerging Evidence from Neuroprotective, Antioxidant and Behavioural Studies

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## ABSTRACT

Hylocereus, commonly known as dragon fruit or pitaya, is a tropical cactus fruit with significant nutritional and bioactivity potential. This review summarizes diverse studies exploring the health-promoting properties and industrial applications of dragon fruit pulp and peel.[1]Both fruit parts are rich in antioxidants, vitamins, minerals, and phytochemicals, such as betalains, flavonoids, polyphenols, and alkaloids, contributing to their anti-diabetic, anti-inflammatory, neuroprotective, anticancer, and antimicrobial effects[2]. Experimental models, including rodents, zebrafish, nematodes, and in vitro assays, have demonstrated the efficacy of the fruit in reducing oxidative stress, improving cognitive function, alleviating anxiety, and protecting against heavy metal toxicity, thereby causing neuromodulation[3]. Dragon fruit contains magnesium and antioxidants that may help regulate neurotransmitters, promoting better sleep quality and reducing mood- and age-related disorders[4]. Collectively, these findings highlight the potential of dragon fruit as a promising sustainable resource for health applications and functional food development.

## INTRODUCTION

Hylocereus is a fruit plant that is indigenous to tropical and subtropical regions of America. It produces fruits known as dragon fruit and pitaya. Pitaya dragon fruit is a rustic fruit belonging to the Cactaceae family and the genus *Hylocereus*[4]. It is known as dragon

fruit because of its bright red skin with overlapping green fins covering the fruit[5]. As dragon fruit flowers usually bloom at night, this led to the birth of terms such as “mistress of the night” and “moon flower,” which indirectly explains why dragon fruit is also called the “belle of the night” or “night-blooming cereus.” The health-promoting potential of pitaya

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fruit is due to the presence of bioactive compounds that confer numerous benefits, such as anti-diabetic, anti-inflammatory, antioxidant, anti-cancer, and antimicrobial properties. As a result of these beneficial actions, the consumption of this fruit has increased in different regions worldwide. Dragon fruit pulp, rind, seeds, flower buds, and dried flowers contain high levels of antioxidants, fiber, vitamin C, and minerals[6]. Dragon fruit is rich in bioactive phytochemicals, including betalains, flavonoids, polyphenols, terpenoids, steroids, saponins, alkaloids, and tannins [7]. Numerous studies have examined the antioxidant capacity of dragon fruit and discovered that it has a high antioxidant capacity. The natural pigments found in dragon fruit peels are typically thrown away as food waste and have not been utilised to their full potential. This is regrettable because the dragon fruit itself has a number of benefits. This crop's greatest benefit is that, once planted, it will grow for roughly 20 years, and one hectare may support about 800 dragon fruit plants. Israel, Vietnam, Taiwan, Nicaragua, Australia, and the US are among the countries where it is grown commercially.[19]

Dragon fruit belongs to the Cactaceae family and is cultivated widely in tropical and subtropical regions. Species including *Hylocereus undatus* (white-fleshed dragon fruit) and *Hylocereus*

*polyrhizus* (red-fleshed dragon fruit) are rich sources of natural pigments and bioactive compounds[5]. Although commonly consumed as a functional food, increasing evidence indicates that dragon fruit may influence neurological health through antioxidant, anti-inflammatory and neurotransmitter-modulating mechanisms.[3,5,6]

The CNS is highly vulnerable to oxidative damage due to its high oxygen requirement and lipid-rich neuronal membranes.[9] Excessive oxidative stress contributes to anxiety, depression, cognitive decline and neurodegenerative disorders[10]. Natural antioxidants from fruits have therefore attracted attention as potential neuroprotective agents[11].

## PHYTOCHEMICAL BASIS OF CNS MODULATION

Dragon fruit contains betalains, flavonoids, phenolic acids, polyphenols, terpenoids, alkaloids and squalene. These compounds may reduce reactive oxygen species, inhibit inflammatory mediators and preserve neuronal integrity. Magnesium and antioxidant components may also contribute to neurotransmitter regulation and sleep-related benefits.

### Current Evidence of Dragon Fruit as CNS Modulator from *in vivo* Studies:

Sr. No	Source/ Model	Treatment/ Methodology	Parameters Evaluated	Major Findings
1	<i>H. undatus</i> pulp and peel extract; rodent models	Regular administration for the assessment of anxiolytics and antidepressant	Tail suspension test, raised plus maze, forced swim test, and neurotransmitter analysis	Produced anxiolytic and antidepressant-like effects by modifying the GABA and serotonin pathways.[12]
2	<i>H. polyrhizus</i> and <i>H. undatus</i> extracts	Aqueous, ethanolic, and methanolic extract	Assays for tyrosinase inhibition, FRAP, and DPPH	Revealed a significant level of antioxidant activity; red dragon fruit had a great antioxidant capacity.[13]
3	<i>H. undatus</i> pulp extract; animal behavioural model	21 days of oral administration	Increased levels of acetylcholine, glutathione,	Enhanced cholinergic activity and antioxidant protection.[14]



			SOD, catalase, MDA, and plus maze	
4	<i>H. undatus</i> extract; zebrafish copper toxicity model	Treatment for copper exposure that is both preventive and curative	Cholinergic function, oxidative stress indicators, locomotion, and survival assay	Decreased neurotoxic stress, elevated cortisol, and anxiety-like behaviour.[15]
5	<i>H. undatus</i> fruit peel extract; <i>C. elegans</i> model	Peel extract treatment for both transgenic and wild-type strains	Gene expression, fluorescence microscopy, neuronal survival, and lifespan	Demonstrated anti-aging and neuroprotective properties via DAF-16-mediated mechanisms.[16]
6	Red pitaya ( <i>Hylocereus undatus</i> ) extract; <i>C. elegans</i> stress model	Administration of fruit extract both prior to and following stress induction	Antioxidant enzymes, the cholinergic system, and behavioural reaction	Prevented and reversed the damage that stress causes to the antioxidant and cholinergic systems [17]
7	<i>H. undatus</i> pulp and peel volatile constituents	Evaluation of squalene-rich extract	Assays for the inhibition of acetylcholinesterase, COX-2, and 5-lipoxygenase	Enzyme modulation may have anti-inflammatory and anti-Alzheimer properties [5]
8	<i>H. polyrhizus</i> peel extract; endurance model	Various oral dosage	Antioxidant assessment and natatory exhaustion test	Decreased oxidative tiredness and increased physical stamina.[7]
9	<i>H. polyrhizus</i> pulp and peel; zebrafish model	Exposure to immersion and behavioural evaluation	Chemical profiling and light-dark behavioural testing	Showed anxiolytic-like effects and may have involved the GABAergic pathway.[18]
10	Dragon fruit phytochemical studies	Evaluation of bioactive compounds	Assays for phenolics, flavonoids, betalains, and antioxidants	Confirmed that by lowering oxidative damage, phytochemicals may help protect the central nervous system.[20]

## CONCLUSION:

Dragon fruit is a multipurpose fruit with significant health advantages and industrial potential. Bioactive substances with potent antioxidant, neuroprotective, anti-inflammatory, and antibacterial qualities are abundant in its pulp and peel.[21] The fruit's capacity to promote cognitive health, lower anxiety, and guard against oxidative and neurotoxic assaults has been demonstrated by these bioactivities, which have been verified in a number of animals. Crucially, the peel—which is frequently disposed of as waste—acts as a useful natural source of pigment. Dragon fruit is a sustainable and affordable

resource for functional foods, nutraceuticals, and natural feed additives due to its long productive lifespan and adaptation to various growing environments [22, 23]. Utilising pulp and peel to their fullest capacity can cut waste and significantly increase the crop's value in commercial and health-related industries.[9]

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