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A Review on Discovering the Satisfying Potentials of *Crassula Ovata*: From Modern Usages to Medication Presentations

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Abstract

The plant Crassula ovata, commonly referred to as green, has saved a lot of interest lately because of its many potentials uses in medicine, environmental sustainability, and biotechnology development. This study summarizes the current body of knowledge regarding Crassula ovata and its therapeutic applications, which include anti-inflammatory, anti-microbial, antioxidant, and wound-healing properties that support its lengthy history of usage and offer promising avenues for drug synthesis. Its potential for environmental remediation and as part of urban green infrastructure is also explored, with a focus on its significance for green roof and phytoremediation applications. Despite its many uses, there are certain obstacles that must be overcome, such as the requirement for a thorough toxicological evaluation and the investigation of its bioactive ingredients. Future study should concentrate on filling in the gaps in our existing understanding, examining the genetic and molecular basis of the plant's therapeutic qualities, and addressing ethical and regulatory issues. The importance of taking a broad approach to investigating the entire range of Crassula ovata's advantages and ensuring its sustainability and preservation for the future is illustrated by this review.

Introduction

Since the beginning of time, people have used plants as medicine. On every continent, medicinal herbs are widely and effectively used. In Asia, herbal medicine has a long history and is used extensively. The majority of commonly used medicinal herbs come from this area, especially China and India. In North America and Europe, herbal medicine is gaining popularity, especially for the treatment of diseases like diabetes brought on by modern diets and lifestyles. Every day, people use products made from medicinal plants to treat illnesses and maintain their health. Cultural and societal diversity are the main causes of the wide range of views in Africa regarding traditional, herbal medicines. The confusion between witchcraft and herbal medicine is another factor contributing to this. Some people favor western treatment and reject the use of therapeutic herbs because they believe it to be superstitious. Millions of Africans, meanwhile, favor traditional forms of treatment [1]. The plant Crassula ovata has been gaining popularity because of its traditional uses and medicinal advantages in addition to its aesthetic appeal as a houseplant. Our understanding of its ecology, effects on distribution,

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and function in traditional medicine has been enhanced by recent study [2]. Traditional medical systems have traditionally utilized Crassula ovata for a variety of purposes, including treating warts, nausea, corns, and diuretics. Its widespread cultural use justifies ethnobotanical research and scientific validation of its therapeutic qualities [3].

This review aims to integrate traditional knowledge with current scientific research in order to methodically investigate the therapeutic potential of Crassula ovata. This article aims to provide a comprehensive overview of Crassula ovata's potential as a source of novel therapeutic agents by analyzing its phytochemical constituents, pharmacological activities, and recent developments in pharmaceutical applications. It will also discuss growth, conservation, and sustainability issues in addition to taking into account its widespread use in relation to responsible usage [4].

As an arborescent crassula of the Crassulaceae family, Crassula ovata is a highly valued succulent species that is renowned for its unique look and versatility. An entire taxonomy of Crassula ovata was discovered after a thorough investigation, which distinguished it from closely related species by identifying distinctive physical traits. For horticulture operations, conservation initiatives, and botanical research, this classification is crucial [5]. Thick, meaty, oval-shaped leaves that are a vivid green with crimson margins when exposed to sunlight are among Crassula ovata's physical traits. The plant can grow up to three meters tall in its natural habitat and has a compact, tree-like structure.

During the winter-to-spring changeover, clusters of white or pink, star-shaped flowers bloom. These distinguishing characteristics aid in its identification and research in the botanical sciences in addition to adding to its appeal as an ornamental plant [4]. Because of its versatility, Crassula ovata, which was formerly restricted to South Africa and Mozambique, is now found all over the world. With its ability to endure severe, rocky, and dry conditions, this plant is commonly cultivated for aesthetic reasons and for its alleged ability to filter the air in gardens or houses. It has been identified as an alien species in Algeria's flora in recent records [2].

Because of its multiple ethnobotanical uses, the jade plant, Crassula ovata, is vital to many cultures. Not only is this lovely ornamental plant highly valued, but it is also adored for its many medical applications in diverse places. Research like the CABI Compendium has highlighted the cultural heritage significance of the jade plant by shedding light on its position as a traditional therapeutic practice [4].

Crassula ovata has been used in many different medical procedures throughout history. A variety of illnesses have been treated with its leaves, either uncooked or in extract form. The plant's succulent leaves are applied topically to minor wounds, burns, and skin irritations in order to aid in their healing. As evidence of its alleged detoxifying qualities, there are other reports of its use in relieving nausea and eliminating toxins. Recent research has examined Crassula ovata's antibacterial and anti-inflammatory properties in an effort to support these traditional use [6].

Beyond its use in medicine, the Crassula ovata has deep cultural and symbolic significance. It is frequently referred to as the "money plant" in many cultures, where it is thought to draw wealth and good fortune. Its use as a live talisman for financial prosperity in households and

enterprises is another example of this symbolic link. The plant is a common gift in many cultural traditions because of its hardiness and evergreen status, which further represent enduring friendship and renewal [4].

The diverse mix of primary and secondary metabolites found in Crassula ovata's phytochemical profile adds to the plant's ecological and therapeutic value. Carbohydrates, proteins, and lipids are examples of primary metabolites that are necessary for plant growth and development. The plant creates secondary metabolites, which include a range of bioactive substances, as a defensive strategy against predators and environmental stress. Recent phytochemical analyses have focused on these chemicals in an effort to determine the plant's potential for use in pharmaceuticals. Numerous bioactive substances, such as flavonoids, terpenoids, and phenolic acids, have been discovered in Crassula ovata in recent research.

These substances are well-known for their anti-inflammatory, antibacterial, and antioxidant qualities. For example, initial bioactivity screens of a novel isocoumarin derivative that was isolated from the endophytic fungus Thielavia sp. in Crassula ovata have yielded encouraging results. These results highlight Crassula ovata's potential as a natural chemical source for creating novel medicinal medicines [1]. Studies comparing Crassula ovata's phytochemical profiles to those of other medicinal plants have brought attention to the plant's distinct bioactive compound makeup. Although many species have similar metabolites like flavonoids and phenolic acids, Crassula ovata has unique medicinal qualities due to the types and quantities of these compounds.

To comprehend the plant's pharmacological potential and direct future studies in natural product drug discovery, these comparative assessments are essential [7]. The increase in antibiotic resistance worldwide and the pursuit of new antimicrobial drugs have sparked scientific interest in Crassula ovata's antibacterial qualities. Reviewing case studies that have investigated Crassula ovata's broad-spectrum antibacterial potential, this section emphasizes the plant's effectiveness against a range of bacterial strains as well as its potential contribution to the creation of novel antimicrobial therapies.

Materials and Methods:

A study on the broad-spectrum antibacterial potential of Crassula ovata was carried out in order to investigate "Broad Spectrum Antimicrobial Potential." According to the study, extracts from the jade plant showed notable inhibitory effects on a variety of bacterial pathogens, such as Escherichia coli and Staphylococcus aureus. This study lays the groundwork for future pharmacological research and offers a fundamental understanding of the plant's antibacterial properties [7]. A study on the phytochemical components of Crassula ovata and their antibacterial activity against various bacterial strains was conducted in order to determine "Phytochemical and Antimicrobial Activity." The results showed that the presence of bioactive substances like terpenoids and flavonoids in the plant's extracts gives them strong antibacterial qualities. This study emphasizes how crucial phytochemicals are to the plant's ability to fight off infections [1]. According to a study on "Wound Healing Properties and Antimicrobial Activity," a methanol extract of Crassula ovata contains both antibacterial and wound-healing qualities. According to the study, the extract had antibacterial properties in addition to

promoting wound healing, indicating that it may have two therapeutic uses: wound care and infection prevention [8]. The High-Performance Thin-Layer Chromatography (HPTLC) fingerprint profile of Crassula ovata was the subject of a study with the goal of standardizing its application according to antibacterial activity. Their study helps to standardize herbal remedies, guaranteeing that Crassula ovata is used consistently and successfully in antimicrobial therapies [9]. Crassula ovata was a part of another study that compared the antibacterial activity of 50 plant extracts. In comparison to other plants, the study demonstrated Crassula ovata's strong antibacterial potential, confirming its status as a viable option for the production of natural antimicrobial agents [10]. In an investigation into the neuroprotective properties of chemicals extracted from Capparis ovata, stigmast-5, 22-dien-3β-ol myristate showed encouraging action in multiple sclerosis mice. Given the phytochemical similarities between the two plants, this study provides a basis for investigating the possible neuroprotective effects of Crassula ovata [11]. The application of Crassula ovata in phytoremediation, particularly its ability to clean up soils tainted with heavy metals like lead, copper, and arsenic, was also mentioned in a study. The study emphasizes the advantages of Crassula ovata for the environment, emphasizing how it may be used to naturally clean contaminated areas [12]. According to a study, there is potential for urban sustainability by utilizing various substrates for green roofs, such as Crassula ovata. The plant's contribution to energy efficiency and biodiversity in built environments is highlighted in the study as part of urban green infrastructure [13]. Plantago ovata's isolated polysaccharides may be used as matrix to create controlled-release medication delivery systems. Crassula ovata may potentially be investigated for its potential in pharmaceutical applications, namely in drug formulation and release, given the structural and functional similarity of polysaccharides among plant species [14]. The wider use of plant-based medicines in aquaculture was highlighted by a study that looked at the in vitro antibacterial efficacy of tropical plant extracts against fish infections. Although Crassula ovata was not particularly mentioned in the paper, its well-known antibacterial qualities point to possible use in the treatment of bacterial infections in aquaculture settings [15].

Understanding Crassula ovata's safety in both conventional and contemporary medicinal applications depends on its toxicological profile. In order to give a thorough picture, this section explores Crassula ovata's acute and chronic toxicity studies, safety profile, and regulatory status, drawing on recent research.

There aren't many studies specifically addressing Crassula ovata's acute and chronic toxicity, but what is known about related species and chemicals offers some insight into possible toxicity profiles. Studies on plant extracts with a composition comparable to Crassula ovata, for example, have the potential to be medicinal, but their safety needs to be assessed using stringent toxicity testing. These findings highlight how crucial it is to evaluate both short-term and long-term effects in order to guarantee the safe application of plant-based therapies [16]. When used in accordance with traditional traditions, Crassula ovata has a largely positive safety profile with rare complaints of negative effects. As with any medicinal plant, though, a comprehensive grasp of its pharmacological and toxicological characteristics is necessary for the shift to contemporary therapeutic uses.

A study emphasizes the necessity of thorough safety assessments, particularly in view of Crassula ovata's growing appeal in complementary and alternative medicine [4]. Regional variations in the evaluation and approval of traditional and alternative medicines are reflected in the regulatory status of Crassula ovata. Before being formally suggested or prescribed, plants used for medical reasons must be evaluated for safety and effectiveness in a number of jurisdictions. According to a study, there is a growing understanding that both traditional and contemporary healthcare frameworks require defined rules to guarantee the safe use of medicinal plants, such as Crassula ovata [12].

Because of its varied phytochemical profile and its therapeutic advantages, Crassula ovata has drawn attention for investigation in pharmaceutical applications and drug development. This section explores Crassula ovata's present use in pharmaceutical formulations, ongoing drug discovery research and development, and the prospects and problems associated with its therapeutic applications.

Although there isn't much information on specific formulations that directly contain Crassula ovata, the plant's bioactive chemicals have been investigated for possible use in medicinal applications. For example, mucilages and polysaccharides from plants with comparable characteristics have been studied for their potential use in drug delivery systems, indicating a possible area of development for formulations based on Crassula ovata [17]. With studies mostly concentrating on its fundamental pharmacological characteristics, the drug discovery process including Crassula ovata is still in its early phases. But research on the transcriptome of Plantago ovata, a plant with related applications, shows that genomic and molecular studies can find bioactive chemicals in Crassula ovata that may be useful for drug development [18].

The absence of thorough toxicological data is one of the primary obstacles to creating pharmaceutical applications from Crassula ovata. Strict testing and validation are necessary to guarantee the safety and effectiveness of plant-based molecules. But this also offers a chance to do comprehensive studies on the pharmacokinetics, pharmacodynamics, and therapeutic potential of Crassula ovata, which could result in new drug formulations for a range of ailments [19].

New research and development opportunities have been made possible by the investigation of Crassula ovata in a number of scientific and medicinal fields. Based on recent research, this part describes the gaps in our present understanding, new areas of interest, and the possibility for pharmacological and biotechnological advancements.

Current Knowledge Gaps

Although studies on Crassula ovata have yielded important insights into its pharmacological characteristics, there are still many unanswered questions, especially regarding its molecular mechanisms of action, bioavailability, and pharmacokinetics. One study noted that it has broad-spectrum antimicrobial potential, but that in-depth research into the precise compounds involved and their modes of action is required, and there are few thorough toxicological evaluations to determine safety profiles for human use, indicating a crucial area for future studies [7].

New Domains of Interest

Recent developments in molecular biology and biotechnology present fresh chances to investigate the genetic underpinnings of Crassula ovata's therapeutic qualities. For example, research on the use of novel procedures to extract hydrocolloids from plant seeds suggests that Crassula ovata may benefit from the application of comparable approaches, which would increase the yield and efficiency of bioactive substances [20]. Additionally, the need for environmentally friendly and sustainable solutions in urban planning and agriculture points to a potential use of Crassula ovata in phytoremediation and green infrastructure initiatives [13].

Possibility of Pharmaceutical and Biotechnological Advancements

There are several opportunities for pharmaceutical innovation due to the adaptability of Crassula ovata and new biotechnological technologies. Enhancement of particular medicinal chemicals inside Crassula ovata may be possible through genetic engineering and synthetic biology, which could result in new medication candidates. Furthermore, the plant's resilience and adaptability, which have been emphasized in research on green roof applications, may be used to create stress-resistant cultivars for extensive use, guaranteeing a steady supply of raw materials for medicinal formulations.

Results

The obtained chemical and biochemical test results clearly showed that *Crassula ovata* has significant antimicrobial activity against Escherichia coli. The aqueous extract can be a promising remedy against E coli infection. Based on the survey results *Crassula ovata* is recognized as a remarkable plant to a list of alien Crassulaciae reported from continental North Africa and should be preserved accordingly. The pharmaceutically potential alkaloids can be obtained by treating the aqueous extraction with acidified water from *Crassula ovata.* The isolated crystals which are probably tetrahydroprotoberberine alkaloid like corydaline and tetrahydropalmatine can have a wide range of application including biological activities, including antiparasitic, antitrypanosomal, and antileishmanial activities. In the mining areas where there is a huge probability of Pb, Cd, and Zn contamination the quality of the soil can be developed by planting Crassula *ovate.* It can also reduce the possibility of contamination of the water in nearby areas. The aqueous and the methanolic extract in HPLC study have shown the presence of phenolic and flavonoid contents. Most importantly the histopathological evaluation has shown a significant wound healing activity and an increased wound healing rates by promoting granulation tissue, epidermal regeneration, angiogenesis, collagen, TGF-β and VEGF. HPTLC and phytochemical profile analysis showed the presence of alkaloids, saponins, steroids and triterpenes. The extract of *Crassula ovata* also revealed the presence of starch granules, trichome, and mucilage. Apart from E. coli it is also useful for Salmonella typhimurium, Listeria monocytogenes, Klebsiella pneumoniae, Corynebacterium xerosis, and Proteus vulgaris and other disease forming pathogens. Therefore, the extract can be used as a good bactericidal and fungicidal. In case of traumatic skin wound the seed oil of *Crassula ovata* has shown remarkable rate of wound healing enhancement and the generation of epithelial cells including angiogenesis and fibrosis. Considering loofah as a substrate the extraction of *Crassula ovata* can be a good choice for developing green roof due to its sustainability and less

shrinkage. The n-hexane extract of *Crassula ovata* has shown an exceptional response to the esophageal carcinoma cell line in presence of vitamin E. To reduce the activity of freshwater pathogens Crassula *ovata* can be a good choice for aquaculture. An analytical study showed that *Crassula ovata* can be arich souce of Si, Mg, Ca, Li, Fe, Al, Na, K, and Ni too. An exceptionally significant study found that there are several biosynthetic pathways and the expression of different genes in *Crassula ovata* with reverse transcription activity while checked in RNA sequencer. Therefore, while coming to the production of genetically modified plant *Crassula ovata* can be a good choice for that.

Discussion

Numerous scientific fields have investigated Crassula ovata, revealing its diverse possibilities for use in medicinal applications, environmental sustainability, and innovative therapeutics. Recent study results are incorporated into this conversation, emphasizing important discoveries and their ramifications for further investigation and use.

Potential for Pharmacology and Therapy

Pharmacological studies have verified the broad-spectrum antibacterial, antioxidant, anti-inflammatory, and wound-healing activities of Crassula ovata. The processes behind these therapeutic effects, however, are still not entirely understood, suggesting a crucial subject for further research. Given the growing demand for innovative treatments worldwide due to chronic wound problems and medication resistance, Crassula ovata has a promising future in drug research, especially in the creation of new antibacterial agents and wound healing products.

Applications in Biotechnology and the Environment

The importance of Crassula ovata for the environment is highlighted by its use in green infrastructure and phytoremediation. It provides workable answers to environmental problems because of its capacity to flourish on polluted soils and enhance urban green spaces. Additionally, the plant's adaptability and resistance point to the possibility of genetic research and biotechnology advancements targeted at maximizing its medicinal properties and environmental advantages.

Considerations for Safety, Regulation, and Ethics

Although there are many potential therapeutic and environmental uses for Crassula ovata, further research is necessary to fully understand its safety profile. The absence of thorough toxicological data emphasizes the necessity of stringent testing to guarantee its safe application in both conventional and contemporary settings. Furthermore, ethical and regulatory issues will become more significant as research into the genetic modification and biotechnological exploitation of Crassula ovata advances, necessitating precise regulations to control its production, application, and commercialization.

Prospects for the Future and Research Deficits

The future of study on Crassula ovata depends on filling in the existing information gaps, especially with regard to the pharmacokinetics and pharmacodynamics of its bioactive

chemicals. Advanced proteomic and genomic research may uncover the genetic underpinnings of its therapeutic benefits, creating new opportunities for medication development. Also, to fully utilize the potential of Crassula ovata, interdisciplinary research integrating environmental science, biotechnology, and pharmacology will be essential.

Conclusion

Crassula ovata has been thoroughly investigated in a number of scientific fields, revealing its enormous promise in pharmacology, environmental sustainability, and biotechnological innovation. Recent research has been summarized in this review, emphasizing the plant's broad-spectrum antibacterial, antioxidant, anti-inflammatory, and wound-healing qualities, which support its traditional uses scientifically and point to potential future pharmaceutical uses.

Furthermore, the use of Crassula ovata in urban green infrastructure and environmental remediation offers a potential strategy for tackling today's environmental issues. Its adaptability and environmental importance are highlighted by its capacity to flourish in challenging environments, aid in the phytoremediation of contaminated soils, and be used in green roof applications.

But there are obstacles in the way of moving from historic use to contemporary medicinal uses and environmental solutions. The necessity for thorough scientific research is highlighted by the existing gaps in our understanding of the plant's safety profile, modes of action, and bioavailability. To ensure the safe and efficient use of Crassula ovata in both traditional and modern contexts, future study should concentrate on clarifying these characteristics.

Furthermore, ethical and regulatory issues will become more significant as we learn more about the genetic and molecular underpinnings of Crassula ovata's therapeutic benefits. In order to fully utilize Crassula ovata and maintain its availability for future generations, it will be essential to ensure ethical benefit-sharing, sustainable use, and appropriate research procedures.

In summary, a variety of natural chemicals with a wide range of medicinal and environmental uses can be found in Crassula ovata. Research on natural products has expanded as a result of its investigation, with exciting opportunities for biotechnological advancements, medicine development, and environmental sustainability. Further multidisciplinary study integrating pharmacology, environmental science, and biotechnology will be crucial to expanding our knowledge and use of this adaptable plant and opening the door to new approaches to environmental and health issues worldwide.

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