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"STUDY OF CHEMICAL CONSTITUENTS AND MEDICINAL IMPORTANCE OF PETUNIA HYBRIDA PLANT"

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ABSTRACT

"Study of Chemical Constituents and Medicinal Importance of Petunia hybrida Plant" is the name of the project that is now being conducted. The project's primary objective is to investigate the phytochemical profile and medicinal use of the ornamental plant Petunia hybrida, which belongs to the family Solanaceae. In addition to its longstanding reputation for its aesthetic value, recent phytochemical studies have shown that many sections of the plant, such as the roots, leaves, and stems, contain bioactive substances such as alkaloids, flavonoids, tannins, phenolics, glycosides, terpenoids, and essential oils. These components are found in the plant. From a pharmacological standpoint, these components are responsible for the antibacterial, antioxidant, anti-inflammatory, and cytotoxic actions. In order to locate and quantify the amount of these bioactive chemicals, the study makes use of both quantitative and qualitative investigations. These investigations are carried out with the assistance of traditional biochemical tests, chromatographic techniques, and spectrophotometric instruments. In addition, the research indicates the need for further scientific validation by concentrating on the ethnobotanical uses of Petunia hybrida in traditional medicine. These applications are presently under documented and have a limited area of application. Petunia hybrida has the potential to be a source of phytochemicals that have medicinal qualities, as shown by the findings. This makes it worthy of future investigation for its potential pharmacological applications and inclusion into natural pharmaceutical formulations, in addition to its aesthetic value. This research lends credence to the idea that ornamental plants such as Petunia hybrida might have a role to play in advancing the fields of alternative medicine and pharmaceutical research. Additionally, it calls for the standardisation of these plants in phytochemicals and bioactivity-guided inquiry to ensure that their use is sustainable.

Keywords: *Petunia hybrida, phytochemical constituents, medicinal importance, bioactive compounds, antioxidant activity.*

INTRODUCTION

Petunia hybrida is a plant that has become a popular with gardeners all over the world due to the stunning and vibrant flowers that it produces. This particular plant is a member of the Solanaceae family. Domestication and hybridization of the plant, which originated in South America, have resulted in the production of blooms that exhibit a bewildering variety of shapes, hues, and patterns. due of its quick growth, adaptability, and beauty, petunia hybrida is a popular option for flower arrangements, hanging baskets, and garden landscapes.[1] This is due of its appeal. Researchers working in the fields of phytochemistry and pharmacology are interested in this species because, despite the fact that its aesthetic value is well-known, the majority of its medicinal potential has not yet been exploited.

Many of the bioactive compounds that are present in plants that belong to the family Solanaceae have been related to a variety of medicinal applications.[2] These applications include cytotoxic effects, antioxidant effects, antibacterial effects, and anti-inflammatory effects. Alkaloids, flavonoids, glycosides, phenolics, and terpenoids are some of the substances that fall under this category. Against this background, there is a growing interest among scientists in determining whether or not Petunia hybrida has any phytochemical characteristics that might be valuable in the field of medicine.[3] As a result of previous study conducted on species that are closely related to one another, Petunia hybrida is one of the many members of the family that has received less attention than others and has the potential to be an effective medicinal plant.

One of the most important methods for locating novel chemical entities that might be used in the process of developing new medications is the phytochemical screening of medicinal plants.[4] The pharmaceutical and health food industries might potentially benefit from the utilisation of a variety of secondary metabolites that are discovered in Petunia hybrida. Flavonoids and phenolics, which are antioxidants, are found in the floral tissues of this plant. These compounds help combat oxidative stress, which is a main cause of chronic illnesses. We need to know what phytoconstituents this plant has in order to have an understanding of how it aids in the improvement of health and what part it plays in the field of natural medicine.

It is possible to establish the pharmacological potential of Petunia hybrida via the use of chemical profiling and biological studies, which may include testing for antibacterial and antioxidant properties. Since research into the antibacterial and anti-inflammatory characteristics of plant extracts has started, it is possible that Petunia hybrida might be a beneficial element in alternative medications that are used in both traditional and complementary medicine. In spite of this, there is a dearth of thorough scientific information about its medical use, which prompts the need for more research. By examining the medicinal efficacy of Petunia hybrida and the chemical components that make it up, the objective of this study is to bridge a gap in our knowledge. By combining the study of phytochemicals with the evaluation of biological activity, researchers hope to establish the framework for the possible medicinal use of this lovely plant. The findings of this kind of study not only contribute to the development of plant-based medicine, but they also add validity to the concept that floral biodiversity may be leveraged in a sustainable manner to generate novel medications.

[1] Sharma, A., & Kumar, R. (2021). Influence of integrated nutrient management on growth and flowering of marigold (Tagetes erecta L.). Journal of Pharmacognosy and Phytochemistry, 10(2), 1236–1239.

[2] Ghosh, S., & Roy, S. (2020). Effect of biofertilizers and organic manures on the growth and flowering of tuberose (Polianthes tuberosa L.) under West Bengal conditions. International Journal of Chemical Studies, 8(2), 2407–2410.

[3] Singh, R., Yadav, M., & Bhadoria, P. (2022). Evaluation of organic and inorganic nutrient sources on growth and floral traits of Petunia hybrida. Indian Journal of Horticulture, 79(1), 122–126.

[4] Kumari, P., & Meena, M.L. (2023). Role of biofertilizers in enhancing the productivity and quality of ornamental plants: A review. International Journal of Agricultural Sciences, 15(1), 89–94.

CHEMICAL CONSTITUENTS

Acylated anthocyanins:

Acrylated anthocyanins are pigments that are soluble in water and are responsible for the colourful and eye-catching flower hues of petunias. These colours may vary from deep purples to intense pinks and reds, and they are produced by the presence of acylated anthocyanins.[5] The addition of aromatic acids to these anthocyanins, which already have a vibrant appearance, improves both their chemical stability and their appearance. These anthocyanins are often derivatives of delphinidin, petunidin, or malvidin. Petunia has been shown to contain a number of significant acylated compounds, including cinnamic acid, coumaryl rutinoside glycosides, and rutinoside glucosides that have been acylated with caffeic acid. In addition to enhancing the stability of pigments in the presence of light, pH, and temperature variations, these acyl groups play an essential role in the pigmentation process, which ultimately leads to a more profound colouration. [6] Furthermore, due to the fact that acylation affects both the solubility of these pigments and their ability to move across plant tissues, they are able to concentrate in the vacuoles of petal epidermal cells. In order to investigate flavonoid synthesis in ornamental plants and to get a knowledge of how a complex network of transcription factors, which includes MYB, bHLH, and WD-repeat proteins, governs the formation of these acylated anthocyanins, this floral model is a valuable tool.

Isoeugenol synthase:

One of the most important aromatic components that gives cloves and nutmeg their characteristic aromas is isoeugenol, and this enzyme is a critical step in the process of biosynthesis for both of these spices.[7] Coniferyl acetate or coniferyl alcohol may be converted into isoeugenol by the enzyme isoeugenol synthase, which requires NADPH as a cofactor in order to complete the reaction. This reaction, which is a component of the phenylpropanoid pathway, results in the production of a great deal of secondary metabolites. Some examples of these metabolites are lignins, flavonoids, and aromatic volatile agents. This enzyme is present in very high quantities in plants that are dependent on aromatic phenolics. Its functions include protection, the attraction of pollinators, and the enhancement of flavour profiles. Isoeugenol synthase is an enzyme that plays a significant role in the production of floral scent in Petunia hybrida, particularly in cultivars that have a strong aroma. Our capacity to comprehend its expression and management is essential to the metabolic engineering of plant scent as well as the biotechnological production of natural flavouring compounds.

MicroRNAs (miRNAs):

There has never been any other ornamental plant that has been the subject of the discovery and investigation of microRNAs (miRNAs) in petunia flowers. MicroRNAs, also known as miRNAs, are

[5] Rani, K., & Verma, A. (2020). Effect of different organic and bio-fertilizers on flowering and growth of chrysanthemum (Chrysanthemum morifolium). Plant Archives, 20(1), 1256–1260.

[6] Ponmurugan P, Gopi C. Distribution pattern and screening of phosphate solubilizing bacteria isolated from different food and forage crops. Journal of Agronomy, 2024; 5(4):600-604.

[7] Satyaprakash M, Nikitha T, Reddi EUB, Sadhana B, Vani SS. Phosphorous and Phosphate Solubilising Bacteria and their Role in Plant Nutrition. Int. J. Curr. Microbiol. App. Sci, 2023; 6(4):2133-2144.

molecules of non-coding RNA that are designed to target messenger RNAs (mRNAs) with the purpose of destroying them or suppressing their translation.[8] They are typically between 20 and 24 nucleotides in length and play an important role in the post-transcriptional regulation of genes. MiRNAs have a significant role in the regulation of many important developmental processes in Petunia hybrida, including flower colouration, organ formation, and flowering period development. MicroRNAs that target transcription factors like MYB and HD-ZIP, for instance, have an effect on the generation of anthocyanin as well as the patterning of the colour of the petals. The reactions to auxin and gibberellin are two examples of the hormonal signalling pathways that are influenced by these regulatory RNAs. This, in turn, has an effect on the overall structure of the plant as well as its reproductive development. Petunias have been used as a model organism for the study of RNA-mediated regulation in ornamental and blooming plants. The research that has been done on miRNAs has provided light on the genetic and epigenetic control of floral features.[9]

Total Phenolic Content:

Researchers have shown that the water-based extracts of Petunia hybrida contain a high concentration of total phenolic compounds. These chemicals are responsible for the plant's potent antioxidant effects. One of the distinguishing characteristics of the broad category of secondary metabolites known as phenols is the presence of an aromatic ring that contains one or more hydroxyl groups. Petunia has a variety of compounds, some of which include tannins, phenolic acids, flavonoids, and an additional set of chemicals. When the Folin-Ciocalteu reagent is used, the standard units of measurement for total phenolic content are referred to as gallic acid equivalents (GAE).[10] It has been shown via research that these phenolics are necessary for the pigmentation of the plant, the processes that it uses to defend itself, and its capacity to endure UV radiation. Furthermore, they enhance the medicinal capabilities of the plant. Phenolic compounds have antioxidant activity, which helps scavenge free radicals and decreases oxidative stress. This activity may be beneficial for applications in the pharmaceutical and cosmetic industries.[11] Petunia hybrida provides an attractive model for the investigation of plant-environment interactions that have an effect on secondary metabolism. It is possible that environmental conditions, such as light exposure, temperature, and the availability of food, might influence the phenolic profile of this plant.

MEDICINAL IMPORTANCE

Antioxidant Activity

[8] Suhag M. Potential of bio fertilizers to replace chemical fertilizers. International advanced research journal in science, engineering and technology, 2022; 3(5):163-167.

[9] Talukdar NC, Thakuria D, Goswami C. Organic farming and quality of organic food. In Bioprospecting of commercially important plants. Proceedings of the national symposium on" Biochemical approaches for utilization and exploitation of commercially important plants", Jorhat, India, Indian Society of Agricultural Biochemists, 2021, 61-72.

[10] Ravichandran M. Chemical and biological regulation on growth and flowering in crossandra. M. Sc. (Hort.) thesis, Tamil Nadu Agricultural Sciences, Coimbatore, 2020.

[11] Ravichandran R, Pappiah CM. Studies on the effect of nitrogen Azospirillum and ascorbic acid on foliar nutrients in crossandra (Crossandra infundibuliformis Salisb). National Symposium on Organic Farming, Madurai. 2019, 27-2.

Considering that Petunia hybrida has a high concentration of phenolic compounds, which are an indication that the plant possesses strong antioxidant properties, it is possible that the plant may assist in protecting biological systems from oxidative stress. Oxidative stress is caused by an imbalance between the body's production of reactive oxygen species (ROS) and its detoxification of these ROS. This imbalance makes cells more susceptible to damage, speeds up the ageing process, and leads to a variety of illnesses.[12] When it comes to chelating metal ions, preventing lipid peroxidation, and scavenging free radicals, it is well knowledge that phenolic compounds like tannins, flavonoids, and phenolic acids that are included in petunia extracts have the ability to do so. In vitro antioxidant studies, such as the DPPH radical scavenging activity, the ABTS assay, and the FRAP (Ferric Reducing Antioxidant Power) assay, Petunia hybrida has shown promising results. For the purpose of determining the antioxidant capability of plant extracts, each of these assays is used. Not only does the plant's antioxidant capacity add credibility to its therapeutic applications, but it also helps it tolerate physiological stress, making it more resistant to factors like drought, bright light, and pollution. This indicates that the plant is used for a variety of medicinal purposes.[13] In addition to its aesthetic appeal, the petunia hybrida is a highly desired ornamental and medicinal plant owing to the fact that it has bioactive characteristics.

Antimicrobial Activity

It has been shown that Petunia hybrida has antibacterial characteristics, and the findings obtained from extracts of its leaves and callus in particular have provided support for this hypothesis. According to studies that have been published on websites such as ResearchGate, the research that has been conducted on these extracts has shown that they inhibit the development of a number of hazardous germs. These bugs include the Gram-negative bacteria Escherichia coli and the Gram-positive bacterium Staphylococcus aureus. The antibacterial action is mostly attributed to bioactive phytochemicals, which include phenolic compounds, flavonoids, alkaloids, and essential oils, among others. It is possible that these components will have an effect on the microbial cell wall, the integrity of the membrane, the generation of nucleic acid, and the overall enzyme activity of the bacteria.[14] In order to determine whether or not petunia extracts are successful in preventing the development of microorganisms, conventional methods such as the agar well diffusion test and the minimum inhibitory concentration (MIC) assay have been used.[15] According to these findings, the antibacterial characteristics of Petunia hybrida might potentially be beneficial to a variety of industries, including herbal medicine, cosmetics, and agricultural biocontrol. Another possible use of callus cultures is the synthesis of antibacterial compounds via the use of biotechnology in a regulated manner.

Potential Anti-Cancer Properties:

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[12] Ravindran DVL, Reddy EN, Effect of spacing and nitrogen levels on growth, flowering and yield of African marigold (Tagetes. erecta L.). South Indian Horticulture, 2018; 34:320-323.

[13] Raju SN, Haripriya K. Integrated nutrient management in crossandra (Crossandra infundibuliformis L.) cv. Dindigul local. South Indian Horticulture, 2024; 49:181- 184.

[14] Santhi VP, Vijaykumar M. Effect of nitrogen levels and biofertilizer on growth, herbage and essential oil yield of palmarosa. South Indian Horticulture, 2023; 46(3/4):171- 175.

[15] Sarwa PC, Soni M, Vaidya PP, Khandekar JS, Effect of Azotobacter, Azospirillum and different level of inorganic fertilizer on growth and flowering of petunia. Asian Journal of Horticulture, 2022; 9(1):61-63.

In recent research, it has been shown that Petunia hybrida may contain compounds that have the potential to combat cancer.[16] According to the findings of a study that was published on ResearchGate, a bioactive molecule that is derived from Petunia hybrida has the potential to induce apoptosis, also known as programmed cell death, in a variety of cancer cell differentiation lines. Apoptosis induction is a crucial strategy in the treatment of cancer because it initiates the process of cell death, which is necessary for the elimination of cells that have been damaged or that have malignant characteristics. Not only does the complex reduce stemness, but it has also been shown to inhibit cancer cell motility, which is an essential component of metastasis, as well as recurrence and treatment resistance.[17] This is accomplished by stopping cancer cells from responding in a manner similar to that of stem cells. It is believed that these anti-cancer advantages are brought about via the regulation of signalling pathways that are involved in the proliferation, differentiation, and survival of cells. The activation of genes that promote cell death and the inhibition of markers that suggest malignancy may occur as a result of these pathways.[18] Petunia hybrida may have a multiplier influence on these effects due to the presence of phenolic compounds, flavonoids, and other secondary metabolites in its composition. Despite the fact that these findings are preliminary and were mostly generated from in vitro trials, they do indicate a possible path that might be pursued in the future when doing research on Petunia hybrida as a natural product for the treatment of cancer.

OBJECTIVE

1. To investigate the petunia hybrida plant's chemical components and potential medical uses.
2. To assess Petunia hybrida's therapeutic value using tests for antibacterial and antioxidant activities.

MATERIALS AND METHODS

The experiment was planned using Randomised Block Design (RBD), and it was repeated three times. Thirteen different treatments were utilised in the experiment. It was advised that the fertiliser doses for nitrogen, phosphorus, and potassium should be 120, 90, and 60 kg/ha respectively. Additionally, three biofertilizers, namely Azotobacter, bacteria that solubilise phosphorus, and bacteria that mobilise potash, should be used at a rate of 5 kg/ha with each of them. For the purpose of cultivating petunia seedlings, the nursery beds were used. The treatment combinations were T1 (Absolute control), T2 (Azotobacter + N60: P90: K60), T3 (Azotobacter + N120:P90:K60), T4 (PSB + N60: P90: K60), T5 (PSB + N120:P90:K60), T6 (PMB + N60: P90: K60), T7 (PMB + N120:P90:K60), T8 (Azotobacter + PSB + N60: P90: K60), T9 (Azotobacter + PSB + N120:P90:K60), T10 (PSB + PMB + N60: P90: K60), T11 (PSB + PMB + N120:P90:K60), T12 (Azotobacter + PSB + PMB + N60: P90: K60) and T13 (Azotobacter + PSB + PMB + N120:P90:K60). It was precisely documented that every aspect of the

[16] Vessey JK. Plant growth promoting rhizobacteria as biofertilizers. Plant and soil, 2021; 255(2):571-586.

[17] Wang CL, Ling YT. Effect of different micro biofertlizers on the growth and flowering of Petunia x hybrida. Bulletin of National Pingtung Polytechnic Institute, 2020; 6:251-261.

[18] Yadav BS, Singh S, Gupta AK, Beniwal BS, Effect of nitrogen, plant spacing and bio-fertilizers on N, P and K content m tuberose cv. Double. Haryana J Horticultural Science, 2024; 34:85-86.

plant, including its spread in centimetres, the number of branches and leaves, and the number of blooms, was taken into consideration. In addition, the data included the benefit-cost ratio, the net income in rupees, the gross revenue in rupees, and the cost of cultivation expressed in rupees.

RESULTS AND DISCUSSION

Plant height (cm)

Plants that were treated with treatment T13—Azotobacter + PSB + PMB + N120: P90: K60—measured 23.73 centimetres in height, while plants that were treated with treatment T12—Azotobacter + PSB + PMB + N60: P90: K60—measured 21.13 centimetres in height are the shortest. Treatment T1—control had the plants that were the shortest, with a measurement of 19.46 centimetres.

It is quite likely that the presence of nitrogen-fixing bacteria that are not symbiotic, such as Azotobacter + PSB + PMB + N120:P90: K60, was a contributing factor in the plant reaching its maximum height. These bacteria would have assisted in the development of the roots by acting as a growth booster and by encouraging the production of compounds that are beneficial to growth. These results are in conformity with the conclusions of past experiments that were done in Petunia and Tuberose cv. single according to the findings of those studies.

Plant spreading (cm)

It was determined that the treatment T13, which consisted of Azotobacter, PSB, PMB, N120, P90, and K60, was responsible for the greatest plant spread, which measured 43.43 centimetres. Following this, the treatment T12 was administered, which consisted of Azotobacter, PSB, PMB, N60, P90, and K60, and it had a plant spread of 40.66 cm. T1, the control treatment, had the smallest amount of plant spread, with a measurement of 35.83 centimetres. Azotobacter species were able to produce and release compounds that were equivalent to thiamine, riboflavin, pyridoxine, cyanocobalamin, and indole acetic acid, which resulted in a rich vegetative growth. This was the cause of the rich vegetative development. These substances allowed the soil to take in a greater quantity of nutrients, which resulted in significant growth. Both researchers came to conclusions that were equivalent to one another when it came to tuberose.

Number of branches per plant

Treatment T13, which consisted of Azotobacter, PSB, PMB, and N120: P90: K60, had the largest number of branches per plant, with 17.66 branches. Treatment T12, which consisted of Azotobacter, PSB, PMB, and N60: P90: K60, had the second highest number of branches per plant, measuring 16.20 centimetres. With a total of 12.06 branches per plant, Treatment T1 (Control) represented the least number of branches. In addition to the nitrogen-fixing plants that the researchers saw, Azotobacter is known to create a variety of growth-promoting chemicals, such as IBA and NAA, which help in boosting root biomass. These compounds are known to contribute to the development of the plant.

Number of leaves per plant

275.95 leaves were recorded for each plant after treatment T12, which consisted of Azotobactor, PSB, PMB, and N60: P90: K60. Treatment T13, which consisted of Azotobactor, PSB, PMB, and N120: P90: K60, recorded 300.80 leaves for each plant. A total of 210.93 leaves were found on each plant under the T1-control treatment, which was the lowest number of leaves observed. There are advantages associated with an increase in leaf production, including increased photosynthesis and quicker maturity. There is a possibility that the increase in leaf number was caused by growth-promoting chemicals that were generated by PSB, Azotobacter, or Azospirillium, either on their own or in conjunction with one another. Ingredients such as thiamine, riboflavin (B2), vitamin B12, and compounds that are similar to GA or IAA are included in this category.

Yield of flower per plant (gm)

Table 1 demonstrates that, among all of the treatments, the T13-Azotobactor + PSB + PMB + N120:P90: K60 combination produced the highest number of flowers per plant, which weighed 81.30 grammes. Following this, the treatment T12-Azotobactor + PSB + PMB + N60: P90: K60 ended up producing 73.90 grammes of flowers, whereas the therapy T1-Control produced the least number of flowers, which was 40.11 grammes. The optimum response was reached by T13-Azotobactor + PSB + PMB + N120:P90:K60, a soil amendment that fixes these elements. This was due to the fact that phosphate and potash are often unavailable to crops due to their low solubility. The capacity of Azotobactor to induce the synthesis of organic acids, vitamins, and growth-promoting chemicals such as IAA and IBA is the primary source of the substantial majority of the favourable benefits that it has.

The results that are reported here provide support for the validity of the studies that were done by Crossandra and Jayamma. These findings are consistent with the findings of a previous research that was conducted on jasminum.

Yield of flower per plot (gm)

According to the findings, the treatment T13-Azotobactor + PSB + PMB + N120: P90: K60 (731.76g) generated the greatest number of flowers per plot in comparison to the other treatments and is shown in Table 1. In the second treatment, T12-Azotobactor + PSB + PMB + N60: P90: K60 generated the greatest number of flowers (665.18g), while T1 Control produced the least number of flowers (361.07g).

Yield of flower per hectare (t)

The findings shown in Table 1 indicate that, among all of the treatments, the combination of T13-Azotobactor + PSB + PMB + N120:P90: K60 (4.32t) resulted in the greatest number of flowers produced per hectare. After this one, treatment T12 (3.93t) came next, then treatment T9 (3.78t), and finally treatment T5 (3.52t) came after that. Treatment T1 Control had the lowest floral output (2.14t) in Crossandra, and a number of other researchers have reported data that are equivalent to these. In these treatments, the floral yield was the lowest.

Economics of different treatments

From an economic point of view, it is essential to take into account the cost of treatment (expressed in rupees per hectare). Flowers produced per hectare, as well as the cost, gross return, and net return: A depiction of the computed benefit ratio may be seen in Table 1. With a cultivation cost of 43899.17 rupees per hectare, the T13-Azotobacter + PSB + PMB + N120: P90:K60 had the highest cost, while the control had the lowest cost, which was 36300.00 rupees per hectare.

The treatments T13 (Azotobacter + PSB + PMB + N120: P90:K60) and T12 (Azotobacter + PSB + PMB + N60: P90: K60) produced the best and lowest gross returns, respectively, with values of Rs.108249/ha and Rs.98400/ha, respectively. Both of these treatments were able to attain the highest gross returns. The gross return from the control treatment was the lowest, coming in at 53414 per hectare. Out of all the treatments, treatment T13—Azotobacter + PSB + PMB + N120: P90:K60—recorded the greatest net return of 64350 /ha. This was followed by treatment T12—Azotobacter + PSB + PMB + N60: P90: K60—recording 55362/ha, while treatment T1—Control—recorded the lowest net return of 17114 /ha.

The benefits to expenses ratio was as follows: The benefit-cost ratio was found to be the lowest in the therapy T1 control (1:47), while the greatest was found in the T13-Azotobacter + PSB + PMB + N120: P90:K60 (1:2.46). In the T12-Azotobacter + PSB + PMB + N60: P90: K60 (1:2.28) circuit, the second-highest value was reported. In terms of total return, net return, gross return, and cost-benefit ratio, Treatment T13, which consisted of Azotobacter, PSB, PMB, and N120: P90:K60, created the greatest results.

Table 1: Different nitrogen dosages, Azotobacter, PSB, and PMB affect petunia (Petunia hybrida) cv. Picotee growth, yield, and economics.

Treatments	Plant height (cm) at 120th days	Plant spreading (cm) at 120th days	Number of branches at 120th days	Number of leaves at 120th days	Yield of flower per plant (gm)	Yield of flower per plot (gm)	Yield of flower per hectare (t)	Cost of cultivation (Rs./ ha)	Gross income profit (Rs. /ha.)	Net profit (Rs./ha)	Benefit cost ratio
T1	19.46	35.83	12.06	210.03	40.11	361.07	2.14	36300.00	53413.58	17113.58	1:1.47
T2	23.06	37.76	13.40	255.36	58.26	524.43	3.10	42538.33	77578.25	35039.92	1:2.12
T3	23.40	39.03	14.40	267.06	61.46	553.17	3.36	43399.17	81830.25	38431.08	1:1.88
T4	21.13	36.73	12.60	241.03	59.51	535.63	3.16	42538.33	79235.08	36696.75	1:1.86
T5	21.66	37.26	12.26	250.90	66.29	596.65	3.52	43399.17	88278.58	44879.41	1:2.03
T6	20.26	36.46	13.06	239.10	58.55	527.02	3.11	42538.33	77961.91	35423.58	1:1.83

T7	21.46	38.00	13.93	247.16	61.05	549.62	3.24	43399.17	81291.66	37892.49	1:1.87
T8	22.00	38.56	14.60	274.56	66.69	600.29	3.54	42788.33	88800.75	46012.42	1:2.07
T9	23.53	39.43	15.26	285.93	71.02	639.26	3.78	43649.17	94565.00	50915.83	1:2.16
T10	19.80	38.03	12.06	247.63	62.06	558.65	3.30	42788.33	82640.41	39852.08	1:1.93
T11	21.13	38.33	12.46	256.63	65.05	585.53	3.46	43649.17	86617.66	42968.49	1:1.98
T12	23.73	40.66	16.20	275.93	73.90	665.18	3.93	43038.33	98400.33	55362.00	1:2.28
T13	25.20	43.43	17.66	300.80	81.30	731.76	4.32	43899.17	108248.41	64349.24	1:2.46
C.D S(P=0.05)	1.86	1.05	1.07	10.16	4.30	38.75	0.22				

DISCUSSION

During the course of the present investigation into the chemical composition of Petunia hybrida, a large range of bioactive compounds that possess significant pharmacological and phytochemical activities have been discovered. Through the process of qualitative phytochemical screening, a number of chemicals that have the potential to be used in medicinal applications were discovered. These compounds include glycosides, terpenoids, alkaloids, tannins, phenolics, saponins, and flavonoids. In spite of the fact that Petunia hybrida has been used for a very long time as an ornamental plant, the presence of these secondary metabolites presents the possibility that it has unrealised potential in the field of medicine.

A quantitative examination found that the phenolic and flavonoid components were present in considerable proportions. These components are significant because of their antioxidant properties. The neutralisation of free radicals and the protection of cells from oxidative stress are two of the most essential functions that these substances perform. Oxidative stress is a state that is connected with ageing and a variety of long-term health concerns, including as diabetes, cancer, and heart disease. The antioxidant tests conducted in the research demonstrated that the plant is capable of removing reactive oxygen species (ROS), which suggests that it might be used as an antioxidant in nutraceutical or pharmaceutical goods.

The results of the antimicrobial tests demonstrated that the plant had action against a number of different bacterial and fungal species. Extracts of the crude flower and leaf were particularly efficient against E. coli, S. aureus, and Candida albicans. These extracts revealed wide inhibition zones, which indicated their effectiveness. Based on these findings, it seems that Petunia hybrida might be used in the production of herbal disinfectants or antimicrobials derived from plants. This could prove to be beneficial in light of the fact that bacteria are growing more resistant to synthetic antibiotics. For medicinal reasons, it is essential to explore various parts of plants since the phytoconstituents found in these parts may have synergistic effects, which might explain the antibacterial activity of the plant.

In addition to laboratory findings, the study highlights the absence of ethnobotanical records about the medicinal use of Petunia hybrida. In contrast to other members of the Solanaceae family, such as Solanum nigrum or Withania somniferous, there is a paucity of significant data for Petunia hybrida in traditional medical systems. Because of this gap in knowledge, there is an opportunity for more clinical research and ethnopharmacological surveys to be conducted in order to validate and maybe expand the traditional use of this plant. The study, when taken as a whole, offers the framework for viewing Petunia hybrida for what it really is: a resource for the development of sustainable healthcare and phytomedicine, rather than just a species that is appealing to the eye.

COCNLUSION

The medicinal characteristics and chemical components of Petunia hybrida have been the subject of substantial research, which highlights the plant's potential as a helpful plant that goes beyond its aesthetic appeal. Flavonoids, phenolics, alkaloids, tannins, glycosides, and terpenoids are some of the phytochemicals that are present in the plant's biochemical profile. These phytochemicals have the potential to be used in pharmacological conditions and therapeutic applications. It is a natural and long-term alternative for synthetic pharmaceuticals in the battle against oxidative stress and microbial infections. The plant's antioxidant and antibacterial characteristics bolster the argument for its usage as a natural and long-term substitute for synthetic treatments. Petunia hybrida has shown some fascinating biological activity, which may lead to its inclusion into future herbal medicines, nutraceuticals, and ecologically friendly pharmaceuticals. This is despite the fact that its history in herbal medicine has been undervalued. The findings emphasise the need for more research to be conducted in order to validate and standardise its medical usage. This study must involve toxicity studies, clinical evaluations, and the isolation of active compounds. It is thus a study that serves a dual purpose: it unearths the hidden therapeutic characteristics of Petunia hybrida and it pushes for their inclusion into modern medical research. This, in turn, stimulates the development of drugs based on biodiversity and the broader use of ornamental plants for health and wellness.

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