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Utilization of Cigarette Butt Filter Waste as an Alternative Growing Medium in Hydroponic Systems

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A B S T R A C T

Cigarette packaging contains cellulose acetate, which is difficult to decompose and pollutes the environment. This study aims to utilize this waste as an alternative growing medium in hydroponic systems. The experimental method was applied to water spinach (*Ipomoea aquatica*) plants by comparing its performance with Rockwool. The implementation stages included physical cleaning, sterilization with 70% alcohol, and boiling to remove harmful chemical residues. Based on observations over 26 days, the Independent Sample T-test results showed a significant value of 0.86 ($p > 0.05$). This indicates that there was no significant difference in plant height and number of leaves. The implication is that cigarette butt waste has been proven to be effective as a growing medium equivalent to Rockwool.

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INTRODUCTION

Cigarette butts are waste from cigarette use in the form of filter and non-filter butts. Cigarette butt waste is a type of solid waste that is often found in the environment, especially in urban areas. Based on research conducted by Hadiansyah and Muchtar (2022), this item is the waste that most pollutes the earth. At least two-thirds of the total 5.6 trillion cigarettes or 4.5 trillion cigarette butts smoked each year are discarded carelessly. What makes cigarette butts even more dangerous is the presence of filters in cigarettes, which consist of thousands of cellulose acetate fibers, a type of plastic that can theoretically decompose biologically, but requires a considerable amount of time. The filter waste in cigarette butts contains many harmful chemicals that can damage plants, animals, and pollute water (Aminah et al., 2024).

The problem of difficult-to-degrade filter waste in cigarette butts can be addressed by utilizing it in agriculture. The filters in cigarette butts contain fibers that can be processed through certain stages to be utilized as items with economic value (Setianto et al., 2023). Cigarette filters made of cellulose acetate have a fibrous structure that allows for good water retention and air circulation for plant root growth. According to Prabhaharan et al., (2024), this material is indeed difficult to decompose naturally, but its biodegradation process can be accelerated through several stages such as initial cleaning, chemical or physical treatment, and inoculation with certain microbes, making it more environmentally friendly and potentially usable as an alternative growing medium. One way to process cigarette filter waste is to use it as an alternative growing medium in hydroponic systems.

Cultivating plants using the hydroponic method can produce better quality and is more efficient in land use compared to conventional methods (Cahyanda et al., 2022). The advantages of hydroponics are that the vegetables produced are more hygienic, have a shelf life of up to 10 days, and no chemicals are used for fertilizers or pest control (Arven et al., 2021). In addition, hydroponic plants do not require a lot of water and do not need to be watered like plants grown in soil. Hydroponic planting techniques are environmentally friendly agricultural techniques (Dinata et al., 2023). Aside from health benefits, the land used makes the house look more beautiful and is also a source of financial gain (Az-Zahra et al., 2021).

However, most growing media commonly used in hydroponic systems are relatively expensive and not entirely environmentally friendly in their production process. This poses a challenge for small farmers and urban farming communities who need affordable and sustainable growing media options. This is expected to reduce cigarette butt filter waste, which can be harmful and pollute the environment, and is expected to become one of the environmentally friendly growing media with great potential in the international market.

LITERATUR REVIEW

Hydroponics System

Hydroponics is a term derived from Greek, namely hydro, which means water, and ponos, which means work or power. Literally, hydroponics is defined as "water work" or a technique of cultivating plants without using soil as a

growing medium. In principle, this method focuses on fulfilling the nutritional needs that are important for plants in the form of a solution dissolved in water. By replacing the function of soil, this nutrient solution is delivered directly to the plant's root zone, making the absorption of nutrients more efficient and controlled. The main advantages of this system over conventional agriculture are its high water efficiency, more hygienic yields due to the absence of soil pathogens, and the ability to be applied in limited areas such as urban areas.

Figure 1. Hydroponic Farming

There are various techniques or systems in hydroponic cultivation that can be adapted to the type of plant, production scale, and available resources. Some of the most used systems include Nutrient Film Technique (NFT), Deep Water Culture (DWC) or floating raft systems, and Drip Systems or drip irrigation systems.

Hydroponic Growing Media

A growing medium is a place where plant roots absorb the nutrients needed by plants (Sari et al., 2022). A good growing medium is one that can support plant growth and life. The function of a growing medium in hydroponic cultivation is as a place for growth and a place to store the nutrients needed for plant growth (Felix et al., 2023).

Cigarette Butt Filter Waste

Figure 2. Cigarette Butt Filter Waste

Cigarette butts are waste from cigarette use in the form of filters or non-filters. Cigarette butt filter waste is made of cellulose acetate fibers that contain microplastics and are very harmful to the environment (Prima, et al, 2021). Cigarette butts contain various types of hazardous chemicals, such as nicotine, tar, and heavy metals. These substances can pollute the environment and cause various negative impacts on human health, ecosystems, and the environment (Fadlia et al., 2023).

When cigarette butts evaporate or are exposed to heat, they release thousands of harmful chemicals that pose a high risk if inhaled by humans or animals. This can pose a serious threat to the land and marine environment. Concrete steps are needed to address the dangers of cigarette butt waste containing cellulose acetate fibers so that they do not further pollute the environment. Based on research conducted by Yuli Ambarwati (2022), cigarette butt waste has been successfully used as an alternative raw material for natural pesticides. This proves that there are still steps that can be taken to mitigate the dangers of cigarette butts.

METHODOLOGY

Research Design

This study used a true experimental method, with a posttest only control group design. The study began with a literature review and in depth research aimed at developing and evaluating the feasibility of alternative growing media made from cigarette filter waste in a hydroponic system. This was followed by the identification of research variables, namely growing media as the independent variable and water spinach (*Ipomoea aquatica*) growth as the dependent variable. The research was conducted in Citayam, Bogor, West Java, Indonesia, from June to July 2025.

Material and Preparation

The materials used in this study were cigarette filters, rockwool, water spinach (*Ipomoea aquatica*), AB mix nutrients, water, and 70% alcohol. The tools used were 3-inch diameter PVC pipes with 10 holes measuring 5 cm in diameter, net pots, 3-inch diameter PVC pipe caps, pH meters, TDS meters, knives, rulers, and stoves.

Cigarette filter waste is then cleaned by removing the cigarette paper and crushing it into small pieces. The cleaned waste is then sorted and soaked in water for four days to reduce any remaining harmful substances. The strict detoxification process continues by soaking the cigarette filter in 70% alcohol for three days. After the soaking process, the filter waste is boiled for three hours to ensure the reduction of toxic compounds. The boiled waste is then dried in the sun for one day until the filters are completely dry. Next, the cigarette filter waste that has undergone this process is processed into a planting medium that is ready for use in hydroponic systems.

Planting and Maintenance

The population in this study was water spinach (*Ipomoea aquatica*) plants, with a sample size of 10 plants. The samples were divided into two treatment

groups, each consisting of five plants. The first group used a growing medium based on cigarette butt filter waste, while the second group used rockwool as a comparison. The division of samples was intended to compare the performance of alternative growing media with conventional growing media commonly used in hydroponic systems. The hydroponic system used was the Wick system.

Water spinach (*Ipomoea aquatica*) seeds were sown for 7 days, after which the water spinach plants were transferred to cigarette filter and rockwool growing media, respectively. AB mix nutrients were added to the water until the AB Mix concentration reached 957 PPM, as measured using a TDS meter. The acidity level of the water used was 5.49, as measured using a pH meter.

Data Collection and Analysis

The parameters in this study were water spinach (*Ipomoea aquatica*) height, leaf length, and number of leaves. Water spinach (*Ipomoea aquatica*) was observed periodically. The quantitative data obtained was analyzed using statistical tests assisted by SPSS software version 25. Data normality was tested using the Shapiro-Wilk method and homogeneity was tested using Levene's Test. To determine the comparison of growth between the two media, a hypothesis test was performed using an Independent Sample T-Test with a significant level of 5% ($\alpha = 0.05$).

RESEARCH RESULTS

Figure 3. Condition of Water Spinach (*Ipomoea aquatica*) Plants on Day 7

The image above shows the growth of water spinach (*Ipomoea aquatica*) plants in cigarette butt filter growing media (F) and rockwool growing media (R) on the 7th day, using the same water and nutrients that have been tested using a TDS meter and pH meter so that the data produced is unbiased. The results show a difference between where water spinach (*Ipomoea aquatica*) grown in cigarette butt filter growing medium (F) grew taller and had more leaves than water spinach (*Ipomoea aquatica*) grown in Rockwool growing medium (R).

(F) **(R)**

Figure 4. Condition of Water Spinach (*Ipomoea aquatica*) Plants on Day 26

The following documentation shows the condition of the water spinach (*Ipomoea aquatica*) plants on the 26th day, which is the harvest period. The documentation shows no significant differences, indicating that cigarette filter planting media (F) can be an alternative to rockwool planting media while also helping to address environmental issues. Further results are explained in the table below.

Table 1. Plant Height Parameter

Treatment	Days After Planting				Average	Net Increase
	7	15	24	32		
F	9	19	39	72	34.75	63
R	8	16	35	66	31.25	58

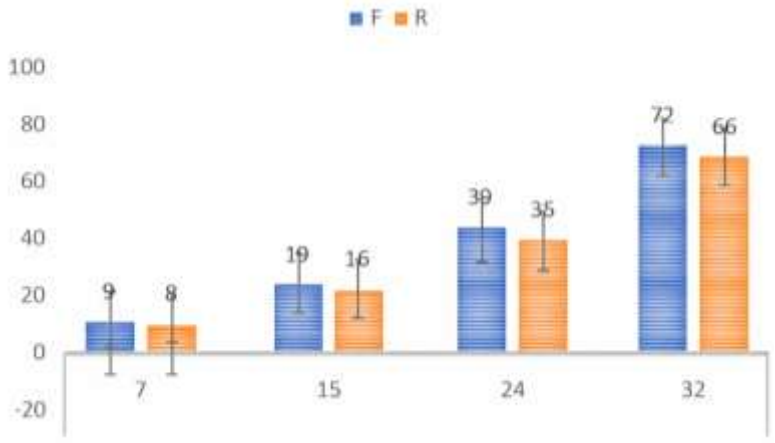

Figure 5. Observation Days

Based on the measurement parameters for water spinach (*Ipomoea aquatica*) growth, a linear growth graph was observed in cigarette butt and rockwool media. The growth graph for plants using cigarette butt media showed good plant growth. This pattern indicates that cigarette butt media is capable of providing a stable growing environment for plant roots, allowing for optimal water and nutrient absorption. In addition, the absence of a decline in the growth graph indicates that cigarette butt media is not toxic to plants after undergoing a processing process. Plant roots can still develop well, which has a direct impact on the continuous growth of plant height. Thus, cigarette butt media not only functions as a plant support but is also able to maintain root conditions that support vegetative growth. This can be seen when compared with plant growth data for plants grown on rockwool media.

The average growth on Rockwool media was 34.7 cm, which was higher than that on cigarette butt media (31.0 cm). This shows that cigarette butt media is capable of supporting good water spinach (*Ipomoea aquatica*) growth. The ability of cigarette butt media to produce growth close to that of standard hydroponic media shows that this media does not inhibit plant growth and has the potential to be an effective alternative planting media.

Table 2. Number of Leaves Parameter

Treatment	Days After Planting				Average	Net Increase
	7	15	24	32		
F	2	4	11	18	9	15.6
R	2	4	9	13	7	11

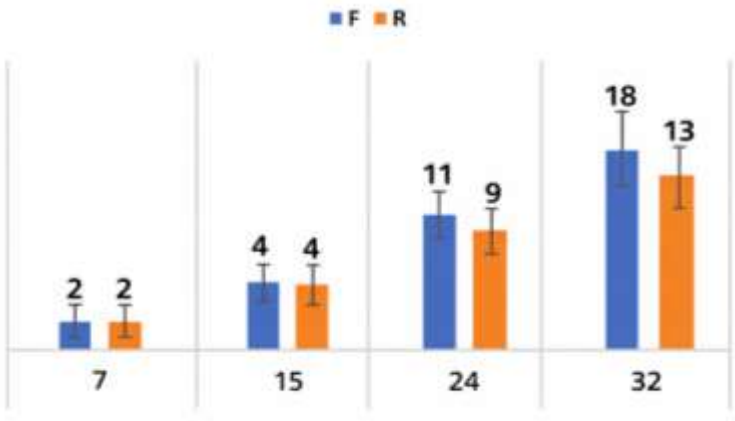

Figure 6. Observation Days

In terms of the number of leaves, observations on days 7 and 15 showed that the number of leaves for both treatments was the same, namely 2 and 4. However, there were differences in growth on days 24 and 32. At this stage, the

plants' need for root aeration, water absorption, and root environment stability increased. Based on the test results and discussion in the document, cigarette butt media has an acetate cellulose fiber structure that can store water and allow for adequate air circulation, thereby supporting root activity and nutrient absorption.

Table 3. Plant Height Parameter

Treatment	Days After Planting				Average	Net Increase
	7	15	24	32		
F	9	19	39	72	34.75	63
R	8	16	35	66	31.25	58

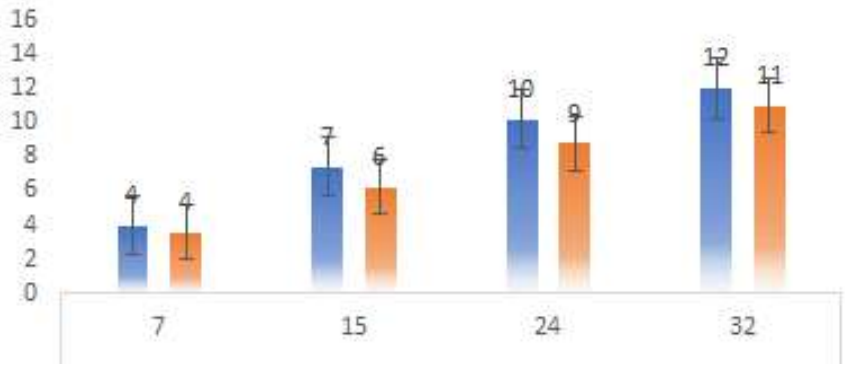

Figure 7. Observation Days

In terms of leaf length, there was no significant difference between water spinach (*Ipomoea aquatica*) plants grown in cigarette butts and rockwool. The data was then statistically tested using normality and homogeneity tests. When testing, the data was normally distributed and homogeneous, so the analysis was continued with an Independent Sample T-Test. This test was conducted to see whether the data was significantly different or not. Based on the test results, the significance value in the T-test was 0.86, which is greater than 0.05, so the null hypothesis was not rejected.

This shows that cigarette butt media has almost the same capabilities as rockwool, so it has the potential to become an alternative medium. This can be seen in the tests conducted on plant height, number of leaves, and leaf length parameters, which show similarities. This indicates that cigarette butt growing media has the potential to be developed further.

DISCUSSION

Based on the results of statistical tests using the Independent Sample T-Test on the parameters of plant height, number of leaves, and leaf length, a significance value of 0.86 ($p > 0.05$) was obtained. This figure shows that there is no significant difference between the growth of water spinach (*Ipomoea aquatica*) in cigarette butt

waste media (F) compared to Rockwool media (R). These results prove that cigarette butt waste has the same capability as Rockwool as a hydroponic growing medium. Although descriptively, growth in cigarette butt medium appeared slightly better at the end of the observation period, scientifically this does not prove that this medium is superior but only shows that this alternative medium can replace the function of Rockwool without significantly reducing plant growth.

This ability can be explained by the physical structure of cellulose acetate, the main material in cigarette filters.

The porous structure of cigarette filters allows for good water absorption and air circulation, like the physical properties of Rockwool. Cigarette filter waste is dominated by cellulose acetate fibers that form a highly intertwined three-dimensional network, but are not arranged in an orderly or separate manner, resulting in a mechanically strong and compact structure. Thus, these fibers can strengthen the roots in cigarette filters during plant growth (Benavente et al., 2019). This supports the research of Mariotti et al. (2022), which states that recycled and sterilized cigarette filters can be a good inert substrate for soilless systems, as they are able to support roots and deliver nutrients effectively like commercial substrates. Acetate cellulose derived from cigarette butts, when thoroughly cleaned and purified to remove toxic combustion residues, has the potential to be recycled and reused. In its pure form, acetate cellulose is a highly valuable polymer, especially in agriculture. One of its applications is in technology, where cellulose acetate is used as a matrix or coating material to regulate the gradual release of nutrients in fertilizers and active ingredients in pesticides. This utilization reduces nutrient loss and environmental impact, making the recycling of cellulose acetate from cigarette butt waste strategically important in supporting sustainable agricultural practices. Additionally, the absence of signs of toxicity or growth inhibition indicates that the sterilization process (boiling and alcohol immersion) successfully removed toxic residues such as nicotine and tar, making the medium safe for plant roots (Benavente et al., 2019).

These results have significant impacts, particularly in terms of the environment and economy. The use of cigarette butt waste provides a win-win solution. Environmentally, it reduces the volume of cigarette butt waste, which is one of the most abundant types of waste in the world and is difficult to decompose. Thus, cigarette butt waste is not only technically viable but also has the potential to support the concept of a circular economy in sustainable agriculture.

CONCLUSION

Based on the results of research and data analysis that has been conducted, it can be concluded that cigarette filter waste has great potential as an alternative growing medium, such as a substitute for Rockwool in hydroponic systems. Statistically, the results of the Independent Sample T-Test showed a significance value of 0.86 ($p > 0.05$), which means that there was no significant difference between the growth of water spinach (*Ipomoea aquatica*) plants in cigarette filter media compared to Rockwool media. This proves that the ability of cigarette filter media to support plant height and leaf count is comparable or equivalent to standard commercial media.

In addition, the successful growth of plants without any symptoms of death or toxicity shows that the processing methods applied, namely water immersion, 70% alcohol sterilization, and boiling, are effective in reducing harmful substances such as nicotine and tar to levels that are safe for plants. The utilization of this waste not only provides a viable agronomic technical solution but also offers a double positive impact: reducing environmental pollution caused by cellulose acetate waste that is difficult to decompose and providing an economical alternative growing medium for small scale farmers and urban farming enthusiasts.

RECOMMENDATION

1. Household and MSME Utilization: Urban farmers and small-scale hydroponic farmers are advised to start using cigarette butt waste as an alternative planting material.
2. Compliance with Sterilization Procedures: For people who want to use this medium, it is highly recommended to follow strict cleaning procedures in accordance with this research method (soaking and boiling). This is important so that any remaining harmful chemicals are completely removed before the medium is used to grow vegetables for consumption.
3. Integrated Waste Management: It is recommended that there be cooperation between environmental communities or waste banks and active smokers to collect cigarette butts separately. Sorting from the outset will facilitate the collection of raw materials and accelerate the process of processing them into useful planting media.

FURTHER STUDY

1. Chemical Residue and Heavy Metal Analysis: The main limitation of this study is that it focuses only on physical growth parameters, namely plant height and number of leaves. Since cigarette filters absorb toxins, future studies need to conduct laboratory tests on harvested plant tissues, such as leaves and stems. The purpose of this analysis is to detect the presence of nicotine, tar, or heavy metal residues such as lead and cadmium that may remain in the plants, to ensure food safety.
2. Cost-Benefit Analysis: Although cigarette butt waste is obtained free of charge, the sterilization process using 70% alcohol and boiling requires operational costs. Further research is recommended to perform a detailed cost analysis to compare whether the total cost of processing this waste is cheaper than the market price of Rockwool, especially for large scale production.
3. Variation in Plant Types and Sample Size: This study only used samples of water spinach (leafy vegetable) with a short harvest period. It is recommended that future studies increase the number of samples to obtain better statistical validity, as well as test the effectiveness of this medium on fruiting plants such as chili peppers or tomatoes, or plants that grow for a long time. This is important to see the durability of the physical

structure of the medium, whether it breaks down or compacts easily when used over a longer period.

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REFERENCES

Ambarwati, Y. Et Al. (2022) 'Edukasi Pengolahan Limbah Puntung Rokok Menjadi Pestisida Nabati Di Desa Sumberejo Kecamatan Sumberejo Kabupaten Tanggamus', Jurnal Pengabdian Kepada Masyarakat (Jpkm) Tabikpun, 3(3), Pp. 167–174.

Aminah., Cahyani, L. A. R., Rahayu, R., "Analisis Dampak Lingkungan Dari Peningkatan Jumlah Pembuangan Sembarangan Putung Rokok Di Gunung." CHEMVIRO: Jurnal Kimia Dan Ilmu Lingkungan, 2(1), 205–21. Arven, S. H., Farma, S. A., & Fevria, R. (2021, September). Perbandingan Tanaman Yang Dibudidayakan Secara Hidroponik Dan Non Hidroponik. In Prosiding Seminar Nasional Biologi (Vol. 1, No. 1, pp. 574-578).

AzZahra, A. A., Samah, D. A., Mahardyka, G. C., Syahputra, M. I., Dewi, P. R. K., & Katmawanti, S. (2021). Pemberdayaan masyarakat melalui pengaplikasian toga hidroponik keluarga: Studi literature review. In Prosiding Seminar Nasional" Sport Health Seminar With Real Action" Ilmu Kesehatan Masyarakat Universitas Negeri Malang.

Benavente, M. J., Caballero, M. J. A., Silvero, G., López-Coca, I., & Escobar, V. G. (2019). Cellulose acetate recovery from cigarette butts. In Proceedings (Vol. 2, No. 20). MDPI.

Cahyanda, R. Q., Agustin, H., & Fauzi, A. R. (2022). Pengaruh metode penanaman hidroponik dan konvensional terhadap pertumbuhan tanaman selada romaine dan pakcoy. Jurnal Bioindustri (Journal Of Bioindustry), 4(2), 109- 119.

Dinata, A. P., Maharani, F. J., Rahmadhani, N. R., Afifah, N., Jasmine, S. L., Huda, S., ... & Khomsah, S. F. (2023). Pemanfaatan Lahan Dengan Menggunakan Sistem Hidroponik Serta Penerapan Ekonomi Kreatif Di Kelurahan Medokan Ayu. Karya: Jurnal Pengabdian Kepada Masyarakat, 3(2), 90-96.

Fadlia, F., Ramadhani, U., Ramadani, I., & Faraidiany, M. (2023). Kerusakan Lingkungan di Lokasi Wisata Puncak Geurutee. Jurnal Sosiologi USK (Media Pemikiran & Aplikasi), 17(1), 63-73.

Function As Natural Insecticide On Armyworm Pest (Spodoptera Litura F.) In Mustard Green (Brassica Juncea L.) Plant', Jurnal Pendidikan Teknologi Pertanian, 7(2), Pp.161–166. Available At: https://doi.org/10.26858/Jptp.V7i2.12795.

Hadiansyah, H., & Muchtar, K. K. (2022). Sosialisasi Bahaya Puntung Rokok Bagi Lingkungan di Taman Lansia Kota Bandung. Jurnal Desain Komunikasi Visual, 1(1), 24-30.

Muhiddin, N., & Lestari, N. (2023). Pengaruh Media Tanam Organik dan Anaorganik terhadap Pertumbuhan Seledri (Apium graveolens L) dengan Sistem Hidroponik DFT. Jurnal Pendidikan Teknologi Pertanian, 9(2), 155-162.

Nasution, A. S. S., Jumiati, E., & Husnah, M. (2024). Pengaruh Penyerapan Air Dan Porositas Pada Keramik Berpori Berbahan Clay Dan Puntung Rokok. Jurnal Energi Baru dan Terbarukan, 5(1), 14-19.

Panjaitan, J., Sipahutar, S., Tafonao, F., Ndruru, K., Zega, A., & Sitompul, C. M. (2021). Pemanfaatan Kembali Sampah Organik Dan Non//Organik Untuk Meningkatkan Kreatifitas Dan Produktifitas Mahasiswa Dalam Pengembangan Tanaman Hidroponik Di Fkip-Uda. Jurnal Darma Agung, 29(3), 350-358.

Prabhaharan, D., Park, H., Choi, O., Abraham, A., & Sang, B. I. (2024). Enhancing cellulose acetate biodegradability in cigarette filters: an in-depth analysis of thermal alkaline pretreatment, microbial dynamics, and breakdown pathway prediction. Microbial Cell Factories, 23(1), 199.

Prima, P. Prima P., Patang, P. And Wijaya, M. (2021) 'Efektifitas Puntung Rokok Sebagai Insektisida Alami Terhadap Hama Ulat Grayak (Spodoptera Litura F.) Pada Tanaman Sawi (Brassica Juncea L.) Effectiviness Of Cigarette

Setianto, S., Kin Men, L., Faizal, F., Mubarok, S., & Suhendi, N. (2023). Sosialisasi Pemanfaatan Limbah Puntung Rokok sebagai Pestisida Nabati. Dharma Saintika: Jurnal Pengabdian Kepada Masyarakat, 1(1), 13–18.

Valupi, H. (2022, January). Pertumbuhan Dan Hasil Microgreens Beberapa Varietas Pakcoy (Brassica rapa. L) Pada Media Tanam Yang Berbeda. In Prosiding Seminar Nasional Pertanian (Vol. 4, No. 1, pp. 1-13).

Velazquez-Gonzalez, R. S., Garcia-Garcia, A. L., Ventura-Zapata, E., Barceinas-Sanchez, J. D. O., & Sosa-Savedra, J. C. (2022). A Review on Hydroponics and the Technologies Associated for Medium-and Small-Scale Operations. Agriculture, 12(5), Article 5. https://doi.org/10.3390/agriculture12050646