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DHT (Diapers Hydrogel and *Tajin*) Fertilizer: Liquid Organic Fertilizer for the Growth of Chili Pepper Plants (*Capsicum frustencens*)

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Abstract: The issue of disposable diaper waste is a significant environmental challenge because it is difficult to decompose, taking between 250 and 500 years, and leads to widespread pollution. The rising volume of diaper waste and the suboptimal disposal of rice wash water (*air tajin*) require innovative solutions. This research offers a novel approach by integrating the water retention capacity of diaper hydrogel with the nutritional benefits of rice wash water into a single Liquid Organic Fertilizer (LOF) formulation. A nutritional hydrogel derived from used diapers can absorb baby urine, which contains ammonia (approximately 60%) and urea (approximately 35%), both of which are essential nutrients for plants. DHT Fertilizer is created by extracting hydrogel from cleaned, used diapers. The hydrogel is heated to 50 °C for 60 minutes, then mixed with 60 mL of rice wash water. This study aims to repurpose these waste materials into "DHT Fertilizer" and test its effectiveness on the growth of bird's eye chili (*Capsicum frutescens*). Experimental Design: This quantitative experiment involved one control plant and one treatment plant, each with a single replication, and was observed over a two-week period. The independent variable was the dosage of DHT Fertilizer, and the dependent variable was the growth of the chili plants. The fertilizer was applied by spraying the plants twice daily, in the morning and evening. The results show that DHT Fertilizer significantly and rapidly increases the growth of bird's eye chili compared to the control plant. This accelerated growth is driven by the ammonia and urea content, while the vitamin B and E components from the rice wash water improve the plant's resistance to weather changes. Additionally, the hydrogel component helps the plant absorb and store water efficiently. DHT Fertilizer serves as an eco-friendly, efficient, and easy-to-use solution to overcome growth vulnerabilities in chili plants.

Keywords: *Capsicum frustencens*; DHT fertilizer; Hydrogel Diapers; Rice Water; Waste.

Introduction

Currently, disposable diapers are a type of waste that is difficult to process and decompose. As times and technology have changed, Indonesian society, especially among housewives, has shifted from cloth diapers to disposable ones because they are considered more practical for both toddlers and the household. The increasing use of disposable diapers creates a new environmental problem. This is because people often discard disposable diapers immediately, and they cannot decompose on their own. The use of baby diapers is directly proportional to the birth rate; the higher the birth rate, the greater the use of baby diapers. According to data from the Central Statistics Agency (BPS) published on December 15, 2021, there are currently 30.83 million children enrolled in early childhood education in Indonesia. Of this number, are infants (under 1 year old), 57.16% are toddlers (1–4 years old), and 29.28% are preschool children (5–6 years old) [1].

The high usage of baby diapers, if not balanced with a system for waste management or utilization, will become an environmental problem. This is because the time required for baby diaper waste to decompose completely is very long, around 250–500 years. The excessive use of baby diapers, particularly in the Sidoarjo region, has become a long-term issue that requires immediate resolution. According to 2024 data from the Sidoarjo Regency Central Bureau of Statistics and ECOTON, the overview of baby diaper usage is as follows:

Table 1. Estimated Diaper Waste Accumulation

Component	Estimated Figure
Sidoarjo Population (2023/2024)	± 2.03 Million People
Estimated Number of Toddlers (± 8%)	± 162,400 Children
Average Diaper Usage	4 - 5 pieces/day
Total Daily Diaper Waste	± 650,000 - 800,000 pieces/day

Baby diapers contain hydrogel, which is a gel that can absorb and retain water. The most common type of hydrogel used is sodium polyacrylate (known as "super absorbent polymer" or SAP in the diaper industry). This material also helps plants retain soil moisture. Polyacrylate under 42 psi can hold a volume of liquid up to 30 times its own weight. This correlates with the compression (pressure) that occurs when the baby sits or lies on the diaper. Polyacrylate allows manufacturers to reduce the weight and thickness of diapers by 50 percent and increase their absorbency [2].

Beyond the issue of diapers, the Indonesian population, which consumes rice as a staple, also faces a long-term challenge. The process of washing rice before consumption produces wastewater known as rice water (often locally referred to as *air tajin*). According to the

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seemingly trivial problem of rice water waste can increase Nitrogen and Phosphorus levels, which may trigger harmful water hyacinth blooms [3]. Furthermore, the accumulation of rice water waste can reduce dissolved oxygen levels, leading to the death of aquatic organisms. The rising volume of disposable diaper waste and the suboptimal disposal of rice water present environmental challenges that demand innovative solutions.

Currently, the utilization of used diaper waste and rice water has begun to gain traction, ranging from beauty and industrial products to construction raw materials. As an agrarian nation, Indonesia requires the latest innovations in liquid organic fertilizer production, one of which involves the utilization of baby diaper waste and rice water.

Currently, the utilization of used diaper waste is being carried out, one of which is by being processed into Liquid Organic Fertilizer (POC). The hydrogel content in used diapers can absorb baby urine, which contains various organic compounds. According to Widiatningrum's reaserch, baby urine content is about 60% ammonia, 35% urea, and 5% other organic substances [4]. This allows the hydrogel in used diapers to bind and absorb the ammonia and urea content resulting from urination, making its utilization as a Liquid Organic Fertilizer very beneficial considering that both of these substances are highly needed by plants [5].

Besides used diapers, rice washing water, commonly called *Air Tajin*, is a household waste that is rarely utilized by the community. Baby diaper waste is used as a plant growth medium because it has advantages needed by plants. Besides containing hydrogel, which functions to retain water, baby diaper waste also has the advantage of containing urine. Human urine contains three macronutrients: Nitrogen, Phosphorus, and Potassium. Among all nutrients, nitrogen is the dominant one [6], [7].

Air Tajin is a waste product with many benefits and a high organic content. Rice washing water is one type of waste commonly found in our daily lives. High rice consumption in daily life leads to a large amount of rice washing water being discarded and rarely utilized [8]. Research on the potential and use of rice washing water waste has been widely conducted. Millawati's research points to the potential of rice washing water as a liquid organic fertilizer for celery plants [9]. Meanwhile, Zistalia's research results show a good influence of the potential of rice washing water as a supplement for oil palm seedlings [10]. There are many ways and methods to treat rice washing water so that it can be used as a liquid organic fertilizer. Research conducted by Fadilah compared the duration of rice washing water fermentation between 1 day and 15 days with compositions between 50% and 100%, showing that the 15-day fermentation duration with 100% composition has an effect on plants [11]. Rice washing water can also increase the total chlorophyll content and plant height growth [12]. Some of the contents of rice washing water include carbohydrates, nitrogen, phosphorus, potassium, magnesium, sulfur, iron, and Vitamin B1 [13]. The benefits of rice washing water for plants are diverse, including increasing fruit weight [7]. plant height, and number of leaves [3].

In Marsha's research, processing diapers is mentioned as an alternative to planting media. Diapers are made from wood pulp, sodium polyacrylate (super gel), polypropylene, and fragrance [14]. It also states that disposable diapers are made of polyethene plastic, which is difficult to recycle and contains microplastics and harmful chemicals [15].

The advantage of baby diaper waste being used as a plant growth medium is that it possesses qualities needed by plants [16]. Having urine in the baby's diaper waste is another advantage, in addition to its hydrogel, which helps retain water. The three macronutrients: nitrogen, phosphorus, and potassium, are found in human urine [5]. Among all nutrients, nitrogen is the dominant one [7]. After fermentation with Effective Microorganism 4 (EM4) to break down its organic compounds, the urine content from the baby diaper waste can also be used as a planting medium. EM4 contains fermentative and synthetic microorganisms, including photosynthetic bacteria (*Rhodopseudomonas sp.*), *Lactobacillus sp.*, *Streptomyces sp.*, *Actinomycetes sp.*, yeast, and cellulose-degrading fungi [9]. Given the aforementioned advantages, diapers can be a solution for planting media and an alternative solution for plant fertilizer, including the chili pepper plant (*C. frustencens*). The Chili Pepper plant (*C. frutencens*) is a member of the *Capsicum* genus whose commodity is most widely utilized by the Indonesian people.

Chili pepper is a plant whose growth is vulnerable to disruption by various factors. Chili pepper is very difficult to cultivate during the rainy season because the plant dies if it gets too much water, and it also wilts quickly during the hot season, which can increase the air temperature [17]. This growth vulnerability is what causes the price of chili pepper to fluctuate. According to the Indonesian Minister of Agriculture, the price of chili pepper surged again after being attacked by plant-disturbing organisms (OPT) and damage to plants due to extreme weather in Indonesia[18], [19]. This condition can be overcome by selecting organic fertilizers, the prices of which are currently also soaring. Pupuk DHT (Diapers Hydrogel and Tajin) is one solution to overcome the vulnerability of the chili pepper plant growth process [20]. Pupuk DHT is a Liquid Organic Fertilizer made from processed hydrogel from used diapers and *Air Tajin* waste. These two types of waste can be processed into environmentally friendly fertilizer. In the utilization process, the hydrogel from used diapers is dissolved in warm water and then mixed with *Air Tajin*. The hydrogel in used diapers that still binds and absorbs ammonia and urea from baby urine, along with the Vitamin B and E content in *Air Tajin*, can help the growth process and the resilience of the chili pepper plant to grow in all types of seasons in Indonesia. The hydrogel in the fertilizer is also useful in helping the plants absorb and store excessive water content, and the Vitamin B and E in *Air Tajin* can help strengthen the plants and act as antioxidants [8].

Pupuk DHT is a Liquid Organic Fertilizer that is applied by spraying it onto the plants. Liquid Organic Fertilizer has several advantages over other fertilisers, namely its environmental friendliness, efficiency, and ease of use [10].

Pupuk DHT is the latest innovation in the process of utilizing used diaper waste and *Air Tajin* waste to enhance the resilience and growth of plants, one of which is the chili pepper plant, which is one of the most valuable and frequently utilized plant commodities by the Indonesian people.This research aims to determine the utilization and processing of diaper hydrogel waste and *Air Tajin* as a liquid organic fertilizer in the growth of chili pepper plants, as well

as the effectiveness of using Pupuk DHT as a support for the growth of chili pepper plants.

Research Methods

This research is categorized as a quantitative study. Quantitative research is empirical research where the data is in the form of numbers and structured explanations [21]. This research also includes experimental research, which is a research method used to find the effect of certain treatments on others under controlled conditions [22]. This study focuses on the effect of DHT fertilizer on the growth of chili pepper plants (*C. frustencens*).

The independent variable in this study is DHT fertilizer, and the dependent variable is the growth of cayenne pepper plants, as measured by plant height. The initial preparation for this research involved selecting diapers specifically used for babies aged 0–12 months. Then, the diapers were cleaned with clean water to remove any attached dirt. After cleaning, the hydrogel inside the diapers was removed and placed into a Beaker. Subsequently, the hydrogel was heated over a flame to 500 °C for 60 minutes. Once it became a gel, it was mixed with 60 ml of rice washing water (*air tajin*). After mixing, the Pupuk DHT solution was put into a sprayer for use. Before use, the fertilizer is fermented for 15 days with the addition of EM4 concentrate.

In the research process, there were four pots of cayenne pepper plants: one control pot and one treatment pot with two replications each. The treatment pots were given liquid organic fertilizer with a composition of hydrogel and rice water 1:1.

The research was conducted for 2 weeks, using chili pepper plants that were 2 months old. The chili pepper plants were given ordinary soil planting media with watering three times a day. The application of Pupuk DHT to the chili pepper plants was given twice a day (morning and afternoon). Measurements were taken once every 3 days. The measurement period spanned 2 weeks, from August 22 to September 04, 2022. The data analysis in this study is descriptive quantitative, where the data obtained is presented in a table, then compared, and the differences explained.

Results and Discussion

This research used 1 control plant and 1 treatment plant, each with 1 replication. The independent variable in this study was the dosage of DHT fertilizer application, and the dependent variable was the growth of the chili pepper plants. The results of the research are presented in Table 1.

From the results above, it can be concluded that the use of DHT fertilizer can increase the growth of chili pepper plants. Pots 1 and 2, which served as the control, showed slow growth during the two weeks of measurement. However, the chili pepper plants in the treated pots 1 and 2, which were given a spray of DHT fertilizer, experienced fast and significant growth. This growth is due to DHT fertilizer containing ammonia and urea elements, which are useful for increasing plant growth [8]. The inclusion of rice-washing water (air tajin) in DHT fertilizer also increases the chili pepper plant's endurance in all weather conditions due to its Vitamin B and E content. According to research conducted by Prasetyo, the use of diaper waste and a mixture of rice water can significantly affect plant growth [19].

Table 1. Results of DHT Fertilizer Application Trial on Chili Pepper Plant Growth

Measurement	Chili Pepper Plant Height (cm)			
	Control		Treatment	
	Pot 1	Pot 2	Pot 1	Pot 2
1	15	17	15	16
2	15	17	16	18
3	16	18	19	21
4	16	19	21	23
5	17	19	24	25

DHT fertilizer contains a Hydrogel component from Diapers which assists in the process of storing excess water, allowing the chili pepper plants to last longer [23]. Furthermore, research by Fajar states that the increase in Nitrogen levels in Hydrogel and Rice-Washing Water Fertilizer occurs due to the breakdown of protein into amino acids with the help of heterotrophic microorganisms (organisms that require organic compounds), such as bacteria, fungi, and actinomycetes [9]. The amino acids then undergo ammonification (a process that breaks down protein, amino acids, and nitrogen-containing compounds) to produce ammonium (NH4). The ammonium is then oxidized by *Nitrosomonas* bacteria into nitrite (NO_2), and the nitrite is oxidized by *Nitrobacter bacteria* into nitrate (NO_3) [24]. In addition to the nitrogen content, the element Phosphorus is absorbed in the form of H_2PO_4 and HPO_4- ions. Phosphorus is a constituent of energy transfer compounds, the genetic information system, and stimulates the growth of flowers and plant organs for reproduction [11]. Another role of the Phosphorus element is in the ripening of fruits and seeds. Conversely, a deficiency in the Phosphorus element can result in the plant's root system being very poor and underdeveloped, and the yield of flowers, fruits, and seeds becoming reduced [25].

Conclusion

Diapers hydrogel and *tajin* fertilizer are effective for the growth of chili pepper plants. The growth of chili pepper plants increases when utilizing DHT fertilizer. The nitrogen and phosphorus content decomposed in the diapers is able to help the growth of the chili pepper plants. This research demonstrates that diaper hydrogel and Tajin fertilizer are effective for the growth of chili pepper plants. These findings offer significant implications for specifically for chili pepper farmers. Furthermore, the study contributes to the existing body of knowledge by highlighting the critical role of agriculture for the new solution fertilizer. Ultimately, these results serve as a foundation for future exploration of the processing of diaper waste and rice waste.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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