บทความวิจัย (Research Article)
วารสารวิชาการสถาบันการอาชีวศึกษาเกษตร ปีที่ 6 ● ฉบับที่ 1 • มกราคม – มิถุนายน 2565

Adsorption of Fabric Dye from Synthetic Wastewater by using Agricultural Waste as Biosorbent

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ได้รับบทความ: 23 ธ.ค. 2564
ได้รับบทความแก้ไข: 31 พ.ค. 2565
ยอมรับตีพิมพ์: 6 มิ.ย. 2565

บทคัดย่อ

The objective of this research was to study the appropriate conditions for the absorption efficiency of local agricultural wastes : corn cob, pomelo peel, pineapple peel and longan peel with the following factors, pH of synthetic wastewater, concentration of synthetic wastewater, absorption time, amount of absorbent material and suitability for absorption synthetic fabric dyes. The results showed that 4 types of agricultural wastes had different absorption efficiency and different absorption factors. It was found that corn cob had the best absorption efficiency of fabric dye. At the appropriate of pH 7, corn cob had an efficiency of 74%. The appropriate concentration of synthetic wastewater affecting the absorption efficiency of corn cob was 2 mg/l with an absorption efficiency of 83%. The amount of 1 g of absorbed material had an efficiency of 88%. The best absorption time of the corn cob was 15 minutes with an efficiency of 92%. The results of the study on the correlation of the absorption efficiency of each parameter showed that there was a relation between corn cob and longan peel in pH, concentration, absorbent content and time. Corn cob was the most appropriate material as the Pearson correlation coffeicient was 1 and its significant value was 0.00. The results of the study of agricultural waste materials used showed that pineapple peels had the lowest absorption efficiency of the waste materials at less than 70%

Keywords : biosorbent, corn cob, longan peel, pineapple peel, pomelo peel

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Introduction

Dyeing industry Chemical processes are mainly used to produce or modify the properties of fibers[1]. Chemicals and dyes are often used as an intermediary with water. Therefore, the dyeing plant uses a large amount of water in the production process, including use energy and fuel to operate machinery or equipment for these reasons, resulting in various environmental impacts, especially water pollution that has become a major problem nowadays. Heavy metal contamination in water from the use of chemicals in the production process, resulting in severe impact on humans and the environment both in terms of health, society and economy[2]. The problem of wastewater from dyes that exceed the standard of effluent quality has a significant impact on the environment. Because fabric dyes are highly toxic, and can't be biodegradable naturally in the global fabric dye industry, approximately 100 tonnes of wastewater contaminated with fabric are released annually [3]. The textile dye industry is one of the major industries in Thailand. The proportion of exports in 2016 (January 2016 - December 2016) was 6 percent and the value was approximately 200,000 million baht[4].

This was the reason why large quantities of wastewater was contaminated with fabric dye, when it was released into the water source. The problem of water pollution and affecting human health. Moreover, the color appearance in the wastewater creates an unstable scenery in natural water bodies, and obscures the sunlight that falls to the surface, making water plants less photosynthetic in addition, fabric dyes are organic pollutants, which increase the BOD and COD contaminated wastewater and lower DO[5]. Most of the wastewater treatment that was contaminated with dyes uses chemical methods. Because dye can be treated well, but rather complicated and expensive. Adsorption by agricultural waste is one of the processes that can effectively treat color in wastewater. It was also a value-added agricultural product that was used as an absorbent, that was less expensive compared to other sorbents such as corn cob, longan peel, pineapple peel and pomelo peel. Adsorption by agricultural waste is an interesting option. This is because it can effectively treat the color in the waste water, and It is the use of agricultural waste materials to be beneficial[6]. In studies have found that many agricultural materials have the ability to absorb dye groups well, such as agricultural materials from corn cob, longan peel, pineapple pee and pomelo peel, etc. The use of agricultural waste shells is very beneficial. Because it is the reuse of waste materials in waste treatment one more time and also inexpensive[7]. This study was Therefore interested in the efficiency of biosorbent for adsorption of agricultural waste.

Absorption of synthetic dyes with banana peels (*Musa x paradisiaca*, ABB and *Musa acuminate*, AAA). The best adsorption efficiency 97.76% at pH 5, the optimum adsorption time 12 hours, and the initial color concentration at 25 mg/l using 1 g of sorbent [8]. The use of sago pulm (*Metroxylon sagu Rottb*) for adsorption of cadmium and lead in wastewater. The adsorption efficiency decreased with decreased particle size and optimum pH at pH 4, adsorption time 24 hours[9]. The use of longan peel for absorption. It was found that the pretreated longan peel had the best adsorption of heavy metal ions at pH 4, with an efficiency of 87.53-97.77%, an optimum time of 1 hour[10].

The objectives of this study were to study the appropriate conditions for the adsorption efficiency as follows: pH of synthetic wastewater, concentration of synthetic wastewater, absorption time and amount of absorbent material and suitable for adsorption.

Materials and Experiment

Materials

1) Agriculture wastes material in communities and fresh markets, In this experiment, four types were used as follows: Corn cob , Longan peel , Pineapple and Pomelo peel
2) malachite green fabric dye
3) NaOH
4) HCl

Equipments

1) Sieve size 100 micrometers.
2) Shaker Model SSL1
3) Analytical balance: resolution 4 positions
4) Spectrophotometer Model UVmini – 1240V
5) pH meter
6) Hot air oven model UF55 187931
7) Laboratory bottle amber

Figure 1 pineapple peel

Figure 2 longan peel

Figure 3 pomelo peel

Figure 4 corn cop

Figure 5 Crushing and screening material

Figure 6 Synthetic dye preparation

Experiment

1. Prepare a stock of malachite green fabric dye, concentrated 10 mg/l, 0.01 g of malachite green, dissolved with distilled water 1,000 ml, and stored in the laboratory bottle amber.

2. To prepare the absorbent material, rinse the absorbent with distilled water and dry it in the sun and dry it at 60° C for 24 hours. Weigh the absorbent and then grind the absorbent. Blender and sift with a 100 micrometer sieve.

3. Batch adsorption process for dye adsorption using agricultural waste sorbent, appropriate conditions for fabric dye adsorption from synthetic wastewater were investigated with corn cob, longan peel, pineapple peel and pomelo peel. The variables affecting the adsorption of dyes from synthetic wastewater were studied, which are detailed as follows.

3.1 To measure the appropriate pH value of synthetic wastewater for dye absorption. Prepare synthetic wastewater with initial pH adjustment of 5, 6, 7, 8 and 9, weigh 1 g of the sorbent, place it in a flask with dye and shake on a shaker at 120 rpm at room temperature for 30 min. Then measure the pH after shaking and place it to precipitate. After that, The resulting solution was analyzed with a spectrophotometer and calculated to determine the elimination efficiency by elimination efficiency equation according to Rataphong et al., 2019[8].

3.2 Initial concentration of synthetic wastewater on dye absorption. Adjust the appropriate pH and weigh 1 g of the sorbent in a flask containing the dye concentration as follows: 2, 4, 6, 8, 10 mg/l. It was shaken on a shaker at a speed of 120 rpm for 30 min. It was analyzed by a spectrophotometer by wavelength 430-475 nm. and the results were calculated to determine the removal efficiency.

3.3 To measure the amount of adsorbent appropriate for absorbing fabric dyes. Adjust the appropriate pH and appropriate concentration after weighing the different sorbents equal to 1, 2, 3, 4, and 5 g. Adjust the appropriate pH and concentration of synthetic wastewater after weighing the appropriate amount of sorbent, shaken on a shaker at a speed of 120 rpm at room temperature for 30 min. Analyzed with a spectrophotometer by wavelength 430-475 nm., the results were calculated to determine the removal efficiency.

The appropriate time for absorption efficiency. The dye was shaken on a shaker at 120 rpm for 30 min. The time required to absorb the dye from the synthetic wastewater was 5, 15, 25, 35, 45 and 90 min. The results were analyzed with a spectrophotometer and the results were calculated to determine the removal efficiency.

4) Batch adsorption analysis was done by elimination efficiency as equation

Removal efficiency : (%) = $\frac{C_{\circ} - C_1}{C_{\circ}} \times 100$

C_0 = Initial fabric dye concentration(mg/l)

C_1 = The concentration of dye after absorption(mg/l)

Results and Discussion

1. The appropriate of pH for adsorption

At the different pH in the synthetic wastewater, it was found that the adsorption efficiency (75%) of corn cob was highest while the assorption efficiency of pineapple peel was lowest as seen in figure 7. This is consistent with the study of Rataphong Hongkriangkrai et al.(2019) found that when the initial pH of synthetic wastewater was different, the adsorption efficiency was different. Because pH affects the adsorption efficiency of each adsorbent, which has different structural characteristics as well as different physical and chemical properties of adsorbents.

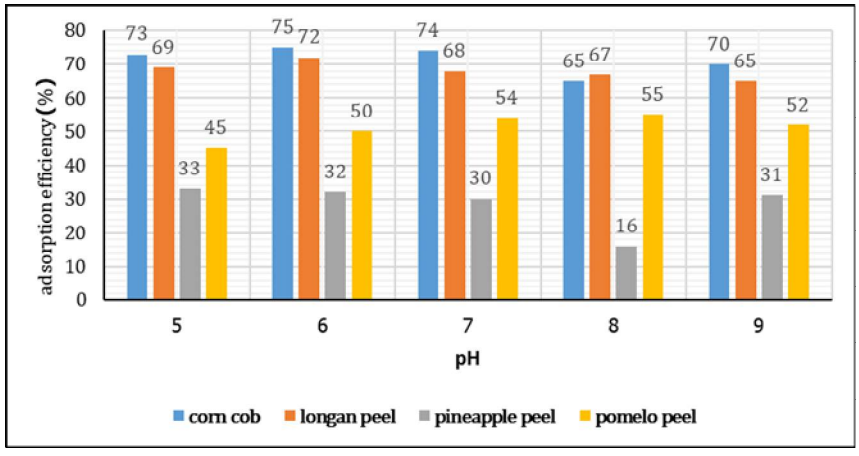

Figure 7 The appropriate of pH for adsorption

2. The appropriate concentrations of synthetic wastewater affecting the adsorption efficiency

At the concentration of 2, 4, and 6 mg/l of biosorbents. It was found that the adsorption efficiency (83%) of corncop was highest when compared with the others. While the concentrationof 8 and 10 mg/l of biosorbent, the adsorption efficiency of longan peel was higher than the others as seen in figure 8. The results were different from those of [11]. with the appropriate concentration for this experiment was 15 mg/l. The results were

different from others reasearch because this study used synthetic wastewater , but in others research used wastewater directly from the dye factory.

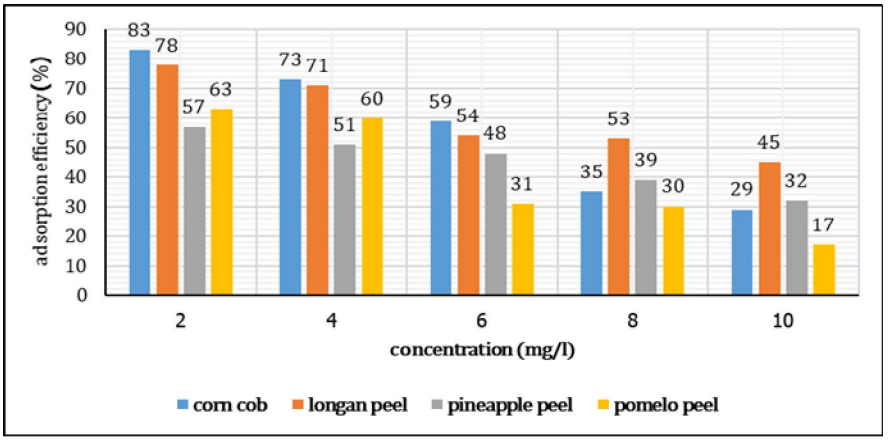

Figure 8 The appropriate concentration for adsorption.

3. The amount of adsorbed material on the adsorption efficiency

At the amount of sorbent 1, 2, 3, 4, and 6 g. of biosorbents. It was found that the adsorption efficiency (88%) of corn cop was highest when compared with the others. the results were different from the research of [11] found that an appropriate amount of sorbent in the experiment was 1 g.

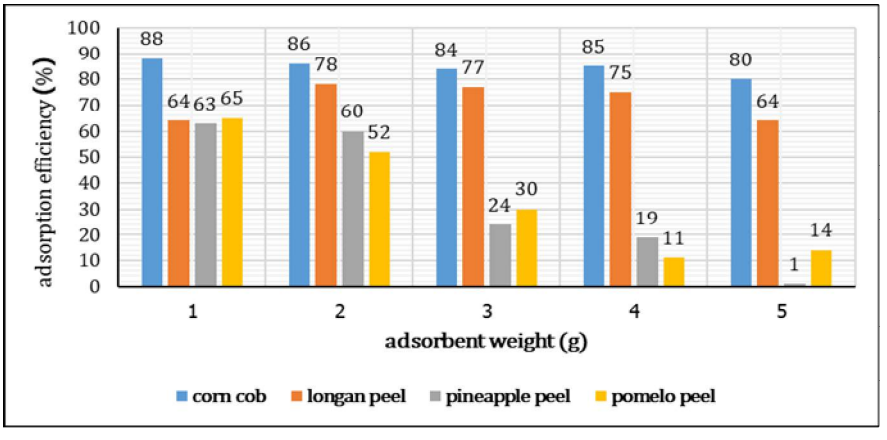

Figure 9 The amount of adsorbed material on the adsorption efficiency.

4. The appropriate time for absorption efficiency

In this experiment, adsorption times were used as follows: 5, 15, 25, 35, 45 and 90 min. Results showed that at different times, the adsorption efficiency of the adsorbents was different. In the use of all four types of agricultural waste sorbents, corn cobs showed efficiency at 15 minutes, the adsorption efficiency of 92 percent, and longan peels were also best absorbed at 15 minutes. Pineapple peel takes 35 minutes to absorb, which is longer than corn cobs and longan peel and pomelo peel absorbs best at 25 minutes.The results of this study are very different from those of , [11] where an appropriate timing was 40 minutes longer than this study. This may be due to different wastewater characteristics. Different adsorption pH and different concentrations resulted in significant differences in adsorption time.

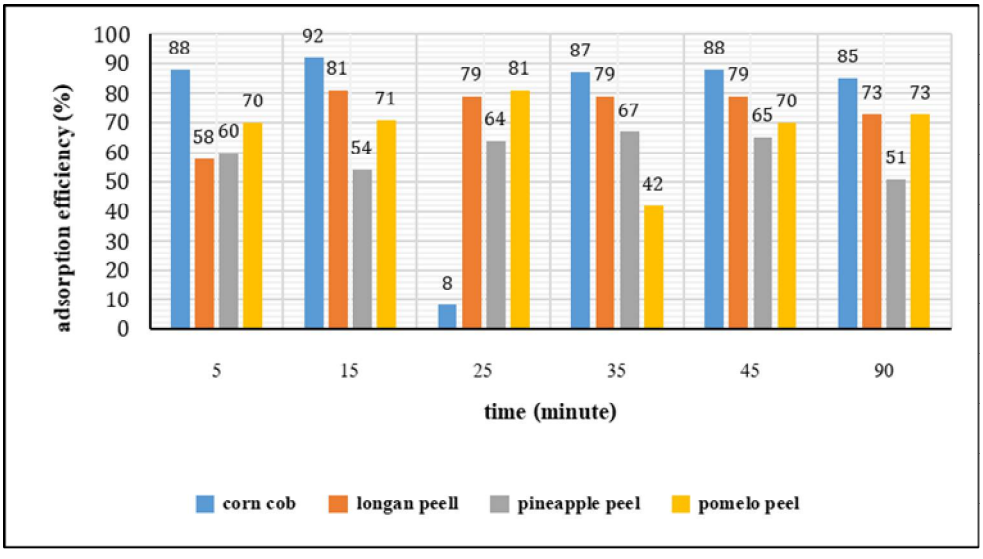

Figure 10 The appropriate time for absorption efficiency

5. The adsorption efficiency of each type of sorbent

In this study, four agricultural waste materials were selected: corn cobs, longan peel, pineapple peel, and pomelo peel. The results showed that (Table 1) corn cobs were most effective at absorbing fabric dyes at pH 6(75%). The best adsorption concentration was 2 mg/l(83%), the best adsorbent amount was 2 g(88%), and the time It has the best absorption efficiency 15 minutes (92%). Longan peel has a secondary adsorption efficiency, the best adsorbed pH 6(72%), the best concentration 2 mg/l(78%), the best adsorption amount 2 g(83%), and the best adsorption time 15 minutes(92%). The third adsorption efficiency is pineapple peel at pH 5(33%), dye concentration 2 mg/l(57%), absorbent content 1 g(63%), and appropriate absorption time 35 min(67%). Pomelo peel absorbency at pH 8(55%), dye

concentration 2 mg/l(63%), optimal absorbency 2 g(65%), and appropriate absorption time 25 minutes(81%). From the four types of agricultural waste materials, it can be seen that corn cop was the best biosorbent material while the pineapple peel showed the lowest adsorption efficiency .

Table 1 Efficiency of adsorption of each sorbent

Absorbent material	Parameter and % efficiency			
	pH and (% efficiency)	Concentration (mg/l) and (% efficiency)	Weight (g) and (% efficiency)	Time (min) and (% efficiency)
Corn Cob	6(75%)	2(83%)	2(88%)	15(92%)
Longan peel	6(72%)	2(78%)	2(78%)	15(81%)
Pineapple peel	5(33%)	2(57%)	1(63%)	35(67%)
Pomelo peel	8(55%)	2(63%)	2(65%)	25(81%)

6. Correlation between the absorption efficiency of fabric dyes and various parameters

The results showed that (Table 2) the dye absorption efficiency of corn cobs was related to the pH of the dye concentration. Absorption time and sorbent weight, with Pearson Correlation approaching 1 and Significant 0.000. The adsorption efficiency of the longan peel was related to pH, concentration, weight and time. However, the correlation was less than that of corn cob because the Pearson correlation of time and weight was not 1 as shown in Table 2. The adsorption efficiency of pineapple peel is correlation to pH and sorbent weight. The adsorption efficiency of pomelo peel was related to pH and sorbent weight, concentration. The results of this study show that four types of agricultural waste, corn cobs have the best absorption efficiency. There are factors affecting adsorption as follows: pH, concentration, weight and adsorption time. It was shown that these factors were significantly related to the adsorbent.

Table 2 Correlation between the absorption efficiency of fabric dyes and various parameters.

parameter	absorption efficiency							
	Corn cob		Longan peel		Pineapple peel		Pomelo peel	
	Pearson correlation	Sig	Pearson correlation	Sig	Pearson correlation	Sig	Pearson correlation	Sig
pH	1.000**	0.000	1.000**	0.000	1.000**	0.000	1.000**	0.000
Concentration	1.000**	0.000	0.497*	0.036	0.411	0.091	0.490*	0.034
(mg/l)	1.000**	0.000	1.000**	0.000	0.789**	0.000	0.909**	0.001
Weight (g)	1.000**	0.000	0.709**	0.001	0.627	0.258	0.657	0.278
Time (min)								

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Conclusions

The results of the study on the absorbency of fabric dyes by using four types of agricultural waste materials, corn cob, longan peel, pineapple peel and pomelo peel. It was found that these agricultural wastes could be used as dyes absorbent in the dye factory wastewater. The adsorption efficiency was found to depend on pH, the concentration of fabric dye, amount of sorbent and adsorption time, which affects the adsorption of fabric dyes in wastewater. The four agricultural wastes were found that corn cob, an easy-to-find material, was the best absorbent of fabric dye. The adsorption efficiency of pH 6 was 75%, the appropriate initial concentration of synthetic wastewater was at 2 mg/l. It has an absorption efficiency of 83%. It uses 1 g of sorbent, with an absorption efficiency of 88% and an absorption time of 15 min, a sorbent efficiency of 92%, which is the most efficient compared to other sorbents. The results of the study on the correlation between the adsorption efficiency of each parameter showed that corn cob and longan peel were related to pH, concentration, adsorbent content and time. Corn cob was found to be the most relevant since Pearson correlation was 1 and its significant value is 0.000. Most of the agricultural waste material used in adsorption is mainly suitable for adsorption of heavy metals such as lead, cadmium, and most of the agricultural waste material used for adsorption is corn cobs[12]. In addition, the study is consistent with previous research showing that lead is highly adsorbed to agricultural materials[13]. And longan peel are used to absorb heavy metals as well, but the efficiency is less than corn cobs. But it is an agricultural waste material that is easy to find in northern Thailand[14]. Using any type of agricultural waste to absorb heavy metals has many advantages, especially in reducing agricultural waste. Agricultural waste is used to make good use of agricultural waste[15].

Acknowledgements

The authors gratefully acknowledge the Laboratory of Environmental Science. Faculty of Science and Technology, Suratthani Rajabhat University

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