Available Online: https://proceeding.researchsynergypress.com/index.php/cset/index
RSF Conference Series: Engineering and Technology
ISSN 2809-6843 (Online) | 2809-6878 (Print)
Volume 1 Number 1 (2021): 479-485

Effect of Solvent Conditions in Process of Extraction of Pectin from Banana Peels for the Adsorption of Fe Metal in Groundwater at UPN Veteran Yogyakarta

Wibiana Wulan Nandari[1], Yuli Ristianingsih[2], Indriana Lestari[3]

[1,2,3] Chemical Engineering Department, UPN "Veteran" Yogyakarta, Indonesia

Abstract
Iron (Fe) is one of the compounds contained in heavy metals which is very dangerous for the survival of living things when in the environment around the residence that has exceeded the threshold. Fe ions can cause turbidity, corrosion, and other impacts. Iron (Fe) is a transition metal and has the atomic number 26. The oxidation numbers of Fe are +3 and +2. Fe is an essential metal for the body which in high doses is toxic. Given the various dangers caused by exposure to Fe metal, it is necessary to treat Fe metal contained in groundwater. One of the most widely used heavy metal processing methods is the adsorption process. In previous studies, many adsorption processes used activated carbon from various materials as adsorbents. In this study, pectin was extracted from banana peels with hydrochloric acid as a solvent at various temperatures and concentrations. The optimum conditions were at 80^{o}C and a concentration of 0.35 N. The pectin obtained was 2.3171 grams.

Keywords: Fe reduction, adsorption, pectin, banana peel

INTRODUCTION

Bananas contain high concentrations of pectin. The pectin content in banana peels is at least 0.9% of the dry weight. The pectin can be extracted in a simple, inexpensive way and can be applied on a small scale (Sirotek et al, 2004). Pectin is a fiber component found in the middle lamella and primary cell walls of plants. Certain plant cells, such as fruit, tend to accumulate more pectin. Pectin usually causes "sticky" properties when someone peels fruit. Industrial applications of pectin can be found in the food industry, cosmetic industry, medicine industry and as an adsorbent for waste treatment. By utilizing pectin from banana peel waste as an adsorbent, it is expected to be able to reduce heavy metal Fe contained in groundwater at UPN Veteran Yogyakarta. In addition, by utilizing banana peel waste as a raw material for making pectin, it can also increase the economic value of the waste and reduce environmental pollution.

Fe is a type of heavy metal that is widely contained in groundwater. The content of Fe in groundwater is usually caused by pollution of industrial wastewater, rust from the installation of waterways due to the oxidation process and the level of Fe is influenced by the condition of the structure of a soil. Fe is easily dissolved in water and is toxic if consumed at a concentration of more than 1.0 mg/L (Depkes RI). Fe content in ground water can damage equipment made of metal, damage clothing and interfere with human health. The groundwater of UPN Veteran Yogyakarta contains high concentrations of Fe metal. It is characterized by yellow deposits on faucets, tubs and walls and when used on the skin surface feels slippery and not rough. The high concentration of Fe contained in the groundwater of UPN Veteran Yogyakarta must be addressed immediately to minimize the toxicity caused by the Fe metal.

The processing method used in this research is the adsorption method which is a simple process for processing heavy metals. Adsorption / adsorption is a process of accumulation of a

Corresponding author:
wibianawulan@upnyk.ac.id; y.ristianingsih@upnyk.ac.id; indriana.lestari@upnyk.ac.id
DOI: 10.31098/cset.v1i1.418

liquid / gas / dissolved solid on a solid surface (adsorbent) caused by intermolecular attractive forces or a result of a force field on the solid surface (adsorbent) which attracts gas, vapor or liquid molecules. to form a thin film. The adsorption process in this study used pectin from banana peel waste. The use of pectin as an adsorbent is due to the sticky nature of pectin and has pores so that it is able to attract metal ions contained in water. The use of banana peels as an ingredient for making pectin is because banana peels contain high levels of pectin, which is 0.9% dry weight. In addition, the use of banana peel waste as the basic material for making pectin can also increase the economic value and reduce the level of environmental pollution.

LITERATURE REVIEW

Pectin is a naturally occurring complex heteropolysaccharide, consisting of a (1, 4)-?-D-galacturonic acid (GaIA) residue bound to various neutral sugars such as rhamnose, galactose and arabinose. Pectin is the second most abundant component in the cell walls of all land plants. Pectin has wide applications in various fields such as gelling agents, emulsifiers or stabilizers because of its non-toxic, biocompatible and biodegradable properties, also like other biopolymers pectin can be used as adsorbent because it has a high adsorption capacity (A. Noreen et al. , 2017),

The adsorption capacity of pectin in adsorbing heavy metals is influenced by two factors. Internal factors (i.e. molecular structure) and external factors (i.e. pH, ionic strength, equilibrium time, temperature, and initial concentration), as well as the mechanism of pectin adsorption and modified form of pectin (i.e. hydrogel and chemically modified pectin). The affinity of pectin with heavy metals also depends on the type of cation, for example Zn2+ is more strongly bound to pectin than Ca2+ and Mg2+ ions, because the electronegativity of Zn2+ is higher than both (Wang et al, 2019).

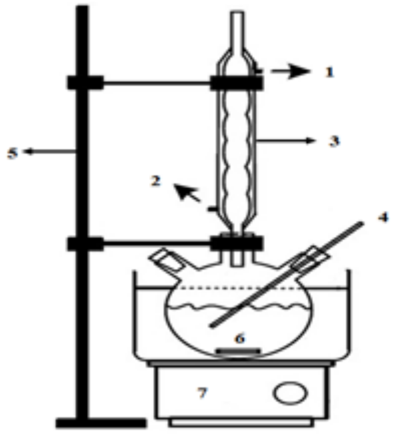
Pectin extraction techniques include solvent extraction (SE), ultrasound-assisted extraction (UAE), subcritical water extraction (SWE), microwave assisted-extraction (MAE) and enzyme assisted-extraction (EAE) (Robledo et al, 2019). The SE technique with acid solvent is the most commonly used method, besides being easy, this technique is more likely to be applied on an industrial scale. The types of acids used include hydrochloric acid, sulfuric acid, nitric acid and sodium hexametaphosphate acid. The results showed that HCl had more pectin extract power than H2SO4. Both are strong acids, but H_2SO_4 has a valence of 2 so that the acidity level is higher than HCl, this is not good in the pectin extraction process because it will tend to cause pectin degradation (Tuhuloula, 2013)

RESEARCH METHODOLOGY

Material

The materials used in this study were Ambon banana peel, distilled water, 0.25N HCl; 0.3N; 0.35N, 96% ethanol, AgNO3, bromthymol blue indicator, filter paper, filter and aluminum foil.

METHODS



Keterangan:
1. Cooler water out
2. Cooler water in
3. Condensor
4. Thermometer
5. *Static*
6. *Magnetic Stirrer*
7. *Hot plate stirrer*

Figure 1. Extraction tools

Raw Material Preparation

Ambon banana peels are cleaned of dirt and then dried in the sun for 3 to 4 days. The dried banana peels are mashed in a blender. The results obtained are called Ambon banana peel powder.

Pectin Extraction Process

25 grams of Ambon banana peel was added with solvent according to the variables. The results obtained are called sour slurry then the sour slurry is heated with variations in temperature (60,70, 80 and 90oC) for 90 minutes. Acid slurry that has been heated, filtered to separate the filtrate. This filtrate is called the pectin filtrate.

Precipitation Process

Pectin filtrate was added with ethanol in a ratio of 1:1 and stirred until smooth. The filtrate was allowed to stand for 2 hours. The pectin precipitate was separated from the filtrate using filter paper.

Filtering and Washing Process

The precipitated pectin was separated from the filtrate using filter paper. The filtering process is carried out repeatedly so that the pectin produced is maximal. In the filtering process, pectin is also washed with ethanol.

Total Fe Adsorption Process Using Pectin

At the initial stage, samples in the form of groundwater from the water source of UPN Veteran Yogyakarta were analyzed by AAS to determine the initial content of total Fe heavy metals. Then added pectin according to the variables into 125 mL of the sample. Stirred for 15 minutes and then allowed to stand for 20 hours. The sample was then analyzed to determine the heavy metal content of Fe after the addition of pectin using AAS.
To study the effect of temperature on the adsorption process, the experimental steps were as follows: A total of 2 g of pectin was added to each 125 mL sample and stirred for 15 minutes. Then the adsorption process was carried out for 1 hour and at temperatures of 20°C, 30°C,

40°C and 55°C. Furthermore, AAS analysis was performed on each sample to determine the residual Fe concentration.

FINDING AND DISCUSSION

This research was conducted through 3 (three) stages, namely: the preparation of raw materials, extraction of pectin and the adsorption of total Fe contained in water using pectin. In the raw material preparation stage, the banana peel is dried before the extraction process is carried out. Banana peel drying is done by drying in the sun for 3 days (8 hours per day). This is done to reduce the water content in the banana peel. After drying in the sun, the dried banana peels are then blended in a blender to reduce the size of the banana peels. After that, the banana peels were placed in the oven for 8 hours at 350C to obtain dry banana peel powder. The banana peel powder is then extracted to obtain pectin. Extraction was carried out using two solvents, namely HCl and acetic acid with concentrations (0.2; 0.25; 0.3 and 0.35 N). the extraction process was carried out for 90 minutes at various temperatures (60, 70, 80 and 900C). The obtained pectin solution was then added with 1:1 ethanol and precipitated for 20 hours to obtain pectin at the bottom and solvent at the top. Pectin is then separated with the solvent and weighed to obtain the yield of sour pectin. The sour pectin obtained was then oven-dried for approximately 2 hours at 350C to obtain dry pectin. The dry pectin was then analyzed for methoxyl, galacturonic, ash alkalinity and ash content. The pectin obtained was then used as an adsorbent in the process of adsorption of total Fe contained in water. The adsorption process was carried out for 4 hours by varying the pectin weight (2,3,4,5 and 6 grams of pectin), adsorption temperature (20, 30, 40, 50 and 600C) and pH (3.7 and 8). The residual Fe content in the water was analyzed using AAS.

Table 1. Characteristics and Yield of Pectin with HCl . Solvent

HCl (N)	Suhu (0C)	Berat Pektin Basah (gr)	Berat Pektin Kering (gr)	Rendemen	berat ekivalen	kadar metoksil	Alkalinitas Abu	Kadar Abu
0,2	60	8,2726	2,1877	0,2068	2173	1,24	2	0,020
	70	18,8068	2,0684	0,4702	2380	1,3	2,1	0,0307
	80	25,2790	3,3077	0,6320	2439	1,3	2,1	0,0171
	90	25,1317	2,5849	0,6283	3333	1,86	2,3	0,0365
0,25	60	10,2765	2,5211	0,2569	2314	1,3	2,1	0,1927
	70	25,5283	2,1571	0,6382	2380	2,23	2,2	0,2541
	80	39,1140	4,3658	0,9779	2500	2,48	2,4	0,1697
	90	39,8507	4,986	0,9963	3846	3,1	2,3	0,4138
0,3	60	11,2320	2,4964	0,2808	2314	1,86	2,3	0,2156
	70	15,8138	2,3202	0,3953	2369	2,23	2,4	0,2791
	80	31,1854	3,532	0,7796	2500	2,61	2,3	0,0825
	90	39,9850	2,3048	0,9996	3571	3,162	2,1	0,3328
0,35	60	11,3241	1,7872	0,2831	2369	2,23	2,2	0,2321

	70	17,3613	2,2016	0,4340	2463	2,35	2,3	0,2067
	80	35,0851	2,3171	0,8771	2631	2,29	2,4	0,231
	90	20,6246	2,1309	0,5156	2564	2,23	2,2	0,2635

Effect of Temperature on Pectin Yield

Based on Table 1, it can be seen that the pectin yield is directly proportional to the increase in temperature. The higher the temperature, the greater the yield of pectin obtained. This is because the higher the temperature causes the solvent particles to move actively to react with the pectin contained in the banana peel so that the yield obtained is greater. The higher the extraction temperature, the kinetics of the protopectin hydrolysis reaction increased so that the pectin yield was greater. This is because the high extraction temperature will help the solvent diffusion into the tissue and can increase the solvent activity in hydrolyzing pectin. The increase in kinetic energy results in the release of polysaccharides from the tissue cells so that the yield is increasing.

Effect of Solvent Concentration on Pectin Yield

Based on Table 1, it can be seen that the higher the concentration of hydrochloric acid, the higher the yield of pectin obtained. This is because the addition of HCl can dehydrate pectin thereby disrupting the stability of its colloidal solution and consequently pectin will be coagulated and during precipitation there is a replacement of water molecules by dissolved molecules resulting in wider contact between the pectin chains resulting in a complex network of polysaccharide molecules. Some of these molecules bind through hydrogen bonds, between these networks water molecules and dissolved molecules are trapped (pectin) and the increased diffusion of the solution into the tissue cells of the material, can further increase the amount of dissolved or released pectin (Ismail et al., 2012). This is consistent with previous studies that the higher the concentration of ethanol, the faster the process of dehydrating pectin, and the higher the yield obtained. (Deasi et al, 2014).

However, at the HCl concentration of 0.35 N, the yield decreased. According to Daryono (2012), if the solvent concentration is too high, the pectin obtained will be degraded to pectic acid. The same thing was expressed by Budiyarti & Etha (2013), that an acid concentration that is too high will cause the degradation of pectin to become pectic acid which makes the acquisition of pectin levels less and less.

CONCLUSION

The higher the temperature, the greater the yield of pectin obtained, but after the temperature reached 80oC the weight of the pectin obtained decreased.

The higher the solvent concentration, the greater the pectin yield. however, at a solvent concentration greater than 0.35 N, the pectin obtained decreased further. This is because the acid is too high will cause the degradation of pectin into pectic acid which makes the acquisition of pectin levels less and less.

In the research on extracting pectin from banana peels, the optimum conditions were at 80^{o}C and a concentration of 0.35 N. The pectin obtained was 2.3171 grams.

REFERENCES

[1] S. B. Nagarajaiah and J. Prakash, “Chemical composition and antioxidant potential of peels from three varieties of banana,” *Asian J. Food Agro-Industry*, vol. 4, no. 01, pp. 31–46, 2011.

[2] Badan Pusat Statistik, “Statistik Tanaman Buah-buahan dan Sayuran Tahunan Indonesia 2019,” *Badan Pusat Statistik Indonesia*. pp. 1–98, 2020.

[3] R. Hidayat, A. Setiawan, and E. Nofyan, “Pemanfaatan limbah kulit pisang lilin (Musa paradisiaca) sebagai pakan alternatif ayam pedaging (Gallus galus domesticus),” *J. Ilmu Lingkung.*, vol. 14, no. 1, p. 11, 2016, doi: 10.14710/jil.14.1.11-17.

[4] D. Seftian, F. Antonius, and M. Faizal, “Pembuatan etanol dari kulit pisang menggunakan metode hidrolisis enzimatik dan fermentasi,” *J. Tek. Kim.*, vol. 18, no. 1, pp. 10–16, 2012.

[5] L. P. Qiu, G. L. Zhao, H. Wu, L. Jiang, X. F. Li, and J. J. Liu, “Investigation of combined effects of independent variables on extraction of pectin from banana peel using response surface methodology,” *Carbohydr. Polym.*, vol. 80, no. 2, pp. 326–331, 2010, doi: 10.1016/j.carbpol.2010.01.018.

[6] M. Megawati and E. L. Machsunah, “Ekstraksi pektin dari Kulit pisang kepok (Musa paradisiaca) menggunakan pelarut HCl sebagai edible film,” *J. Bahan Alam Terbarukan*, vol. 5, no. 1, pp. 14–21, 2016, doi: 10.15294/jbat.v5i1.4177.

[7] S. I. Timang, S. M. Sabang, and Ratman, “Analisis kadar pektin pada kulit pisang kepok (Musa paradisiaca) dan pisang raja (Musa sapientum),” *J Akad. Kim*, vol. 8, no. 2, pp. 112–116, 2019, doi: 10.22487/j24775185.2019.v8.i2.2757.

[8] M. P. Putri, P. A. Lukis, and L. P. Mawarni, “Isolation and characterization of pectin from waste of ‘raja nangka’ banana peels (Musa acuminata (AAA cv)),” *EduChemia (Jurnal Kim. dan Pendidikan)*, vol. 5, no. 1, p. 60, 2020, doi: 10.30870/educhemia.v5i1.6737.

[9] A. N. Rizqi, B. Susilo, and R. Yulianingsih, “Pengaruh pre-treatment bahan baku dan waktu ekstraksi terhadap karakteristik pektin kulit pisang raja (Musa paradisiaca),” *Bioproses Komod. Trop.*, vol. 3, no. 1, pp. 58–67, 2015.

[10] A. Tuhuloula, L. Budiyarti, and E. N. Fitriana, “Karakterisasi pektin dengan memanfaatkan limbah kulit pisang menggunakan metode ekstraksi,” vol. 2, no. 1, pp. 21–27, 2013.

[11] A. Noreen *et al.*, “Pectins functionalized biomaterials; a new viable approach for biomedical applications: A review,” *Int. J. Biol. Macromol.*, vol. 101, pp. 254–272, 2017, doi: 10.1016/j.ijbiomac.2017.03.029.

[12] B. M. Yapo, P. Lerouge, J. F. Thibault, and M. C. Ralet, “Pectins from citrus peel cell walls contain homogalacturonans homogenous with respect to molar mass, rhamnogalacturonan I and rhamnogalacturonan II,” *Carbohydr. Polym.*, vol. 69, no. 3, pp. 426–435, 2007, doi: 10.1016/j.carbpol.2006.12.024.

[13] L. Kurniasari, I. Riwayati, and S. Suwardiyono, “Pektin sebagai alternatif bahan baku biosorben logam berat,” *J. Momentum UNWAHAS*, vol. 8, no. 1, p. 114668, 2012.

[14] R. Wang, R. Liang, T. Dai, J. Chen, X. Shuai, and C. Liu, “Pectin-based adsorbents for heavy metal ions: A review,” *Trends Food Sci. Technol.*, vol. 91, no. May 2018, pp. 319–329, 2019, doi: 10.1016/j.tifs.2019.07.033.

[15] V. R. Robledo, L. Isabel, and C. Vázquez, “Pectin - Extraction, Purification, Characterization and Applications,” *intechopen*, pp. 1–19, 2019, doi: 10.5772/intechopen.8558.

[16] A. Budiyanto, B. Besar, and P. Pascapanen, “Pengaruh suhu dan waktu ekstraksi terhadap karakter pektin dari ampas jeruk siam (Citrus nobilis L),” *J. Penelit. Pascapanen Pertan.*, vol. 5, no. 2, pp. 37–44, 2019, doi: 10.21082/jpasca.v5n2.2008.37-44.

[17] Y. Ristianingsih, I. F. Nata, D. S. Anshori, and I. P. A. Putra, “Pengaruh konsentrasi HCl

dan pH pada ekstraksi pektin dari albedo durian dan aplikasinya pada proses pengentalan karet," vol. 3, no. 1, pp. 1–5, 2014, doi: 10.20527/k.v3i1.135.

[18] M. Sandarani, "A review: different extraction techniques of pectin," *J. Pharmacogn. Nat. Prod.*, vol. 03, no. 03, 2017, doi: 10.4172/2472-0992.1000143.

[19] L. K. Ariesti, F. Waharina, and Y. Ristianingsih, "Pengaruh konsentrasi hcl dan komposisi campuran kulit pisang pada ekstraksi pektin dari kulit pisang dan aplikasinya pada proses pengentalan karet," *Pros. Semnas Tek. Kim. Indones. 2015*, pp. 1–8, 2015.

[20] R. Fakhrizal., Rizqi , F., & Yuli, "Reduksi logam Cr total limbah cair sasirangan menggunakan metode adsorpsi dengan ekstrak pektin dari kulit pisang," *Pros. Semin. Ind. Kim. dan SDA 2016*, pp. 19–24, 2016.

[21] A. Mugiyantoro, I. Husna Rekinagara, C. Dian Primaristi, and J. Soesilo, "Penggunaan bahan alam zeolit, pasir silika, dan arang aktif dengan kombinasi teknik shower dalam filterisasi Fe, Mn, dan Mg pada air tanah di UPN 'Veteran' Yogyakarta," *Proceeding Semin. Nas. Kebumian ke-10*, no. 492, pp. 1127–1137, 2017.

[22] Sirotek, K., Slovakova, L., Kopecny, J. & Marounek, M. 2004. Fermentation of pectin and glucose, and activity of pectindegrading enzymes in the rabbit caecal bacterium Bacteroides caccae. *Letters in Applied Microbiology*, 327–332.